THE NEW IRRIGATION ERA

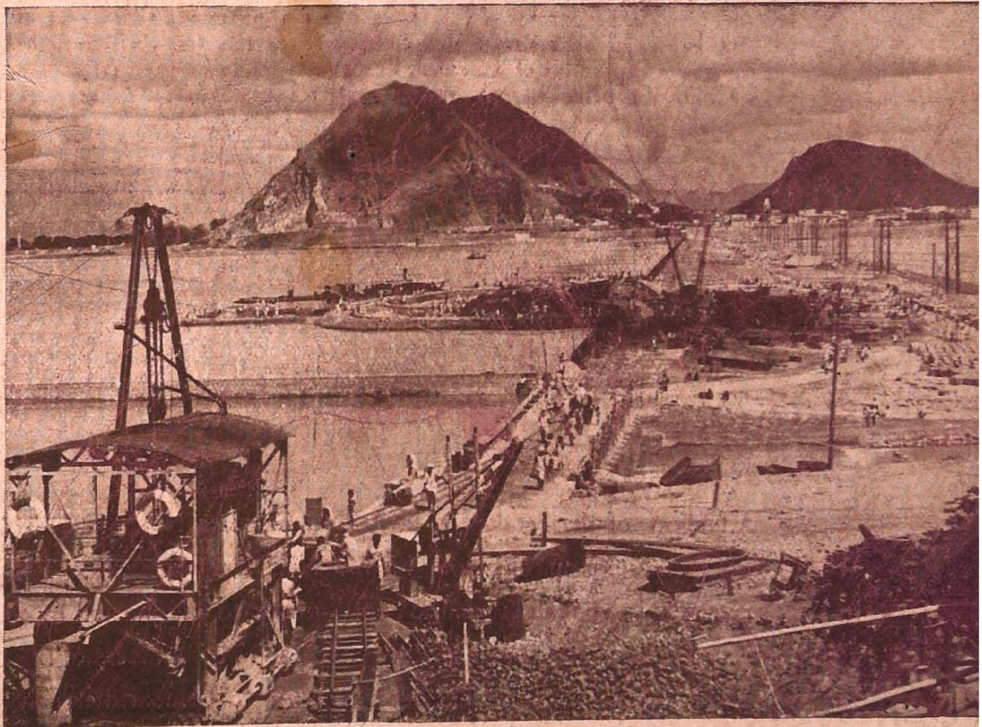
JOURNAL OF THE IRRIGATION BRANCH, MADRAS P.W.D.

VOLUME III
NUMBER 3

NOVEMBER 1952

ISSUED

BI-MONTHLY



GENERAL VIEW OF THE KRISHNA ANICUT.

FOR DEPARTMENTAL CIRCULATION ONLY.

OUR FRONT COVER.

GENERAL VIEW OF THE KRISHNA ANICUT.

In the Front Cover of Volume I Number 2 of the "Era" for "April-June 1950," "a view of the Bezwada Anicut head and under sluices" was printed.

This Anicut across River Krishna is situated between two hills near Vijayawada It is 3785' long and its crest level is at + 47.05. It is founded on a natural sandy bed. The anicut consists of a body wall founded on two rows of wells nine feet deep and the body wall is six feet wide at the crest and is 16' high. The crest is fitted with six feet falling shutters. These shutters could be tripped under hydraulic pressure from the Valve houses, located on either side of the anicut A steam plough is also used to lift the shutters whenever necessary and thus regulate the water levels over the anicut. The anicut serves an ayacut of 11 lakhs of acres under the Krishna Delta System.

Successive and sudden floods of the River Krishna during the S. W. Monsoon of last year (1952) induced deep scours in the rear aprons and by retrogression of levels, a breach occurred in a portion of the body wall of the anicut.

The Front cover of this issue shows a panoramic view of the anicut with the breach site ring-bunded on the upstream side. Elsewhere in this issue, will also be found an article on the outlines of restoration of the anicut with a pictorial supplement giving the progress of the successful work aimed at affording uninterrupted irrigation supplies, despite unexpected occurrences.

CONTRIBUTIONS INVITED.

Attention of the readers is invited to Circular No. 392/51-195 dated 26-11-1952 inviting articles and papers for publication in the New Irrigation Era. The Chief Engineer regrets that in spite of appeals and invitations, the contributions to the journal by the Officers of the Department and others have been much below expectations. The Officers of the Department, Principals of the Engineering Colleges, Officers of the Sister Engineering Departments in the State and others interested in the Science and Development of Irrigation are requested to contribute articles and papers in very good numbers.

For 'Instructions to Contributors' reference is invited to pages 245, 246, 247, 248 of Volume II. Copies may be had on writing to the Editor, Post Box No. 416, Chepauk, Triplicane, Madras-5.

THE NEW IRRIGATION ERA

Published by the Irrigation Branch of the Madras Public Works Department, Madras (5), South India.

(For Departmental Circulation only)

" I believe in Hands that work,
Brains that think and
Hearts that love."

—Elbert Hubbard.

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CODE OF ETHICS.

It shall be considered unprofessional and inconsistent with honourable and dignified bearing for any member of the service of Engineers :

To act for his employers in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered to his employers.

To attempt to injure falsely or maliciously, directly or indirectly the professional reputation, prospects, or business of another Engineer.

To attempt to supplant another Engineer after definite steps have been taken toward his employment.

To participate in competitive bidding on a price basis to secure a professional engagement.

To compete with another Engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another.

To review the work of another Engineer for the same client, except with the knowledge or consent of such Engineer, or unless the connection of such Engineer with the work has been terminated.

To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the profession.

To use the advantages of a salaried position to compete unfairly with Engineers in private practice.

To use undue influence or offer commissions or otherwise to solicit professional work improperly, directly or indirectly.

To act in any manner or engage in any practice which will tend to bring discredit on the honour or dignity of the Engineering Profession.

—*With acknowledgments to the " American Society of Civil Engineers."*

EDITORIAL

WE are now in the throes of the birth of a new State, the Andhra State. Both sections of the old State were dependent on the other for many of their needs. Each of these has to look after itself and its own resources for sustenance in future. That would mean we have now got to gird our loins and develop our resources to the fullest possible extent, both irrigational and industrial. Engineers have a great part to play in this. Devotion to work, intelligence and foresight, ability to anticipate things are *sine-qua-non* for a successful Engineer. Examine yourself and see if you possess them; if you do not, make a beginning to-day to develop them. That is the need of the hour.

HOW WOULD YOU DO IT?

Some of the most fascinating chapters in the life and memory of an engineer are those which deal with the unusual and unexpected situations which almost got him down but from which he finally emerged the victor.

—H. J. Gilkey.

An eight-storey, light manufacturing building was of brickwood mill constuction, that is, the beams and girders carrying the heavy plank flooring were supported by heavy timber interior columns and exterior brick bearing walls. Serious settlement of some of the columns occurred in some of the upper floors, and the city building department was on the verge of ordering that the building be vacated immediately. This would have involved considerable expence since many tenant firms were involved.

A careful inspection showed no general distress or weakness in any specific major member. It was apparent, however, that many of the columns had been cut an inch or two short at the time of erection, and that this deficiency had been remedied by the use of plank blocking. A safe and inexpensive remedy was found by the engineers investigating the problem. What would you have done in this situation?

EDITOR'S NOTE: The above problem, is the first of a series drawn from actual experience and designed to demonstrate how one engineer overcame one of those bugs with which every engineer is familiar. Such experiences are an important part of an engineer's post-college education. Hoping that these problems will prove valuable to those who have never encountered them before and entertaining to those whose memories are thus drawn back to similar experiences of their own, the editor welcomes contributions to this column.

For solution to problem, please vide page 13. Alternative solutions are invited and if found interesting and feasible, will be published with appreciation in the New Irrigation Era.

(Adapted with modifications from 'CIVIL ENGINEERING', Feb. '52.)

Seepage through Earth Dams

By Sri A. R. Venkatachari, B.E., M.I.E. (Ind), M.Am. Soc. C.E., I.S.E.

Some of the works on progress in Lower Bhavani Project require a good appreciation of the theoretical aspects.

We have started the earth dam. Work has been started on both the flanks. The idea in starting the flanks is to acquire experience for tackling the deeper and more difficult sections.

We have not been building very high earth dams or embankments so far except just a few. Most of our bunds are less than 40 feet high. The maximum we have gone upto is around 60 feet.

Hitherto, we were accustomed to build embankments of homogenous sections. The soil type used was more of clayey loam. For dams of reasonable height, zoned sections are to be used rather than homogenous sections. One of the considerations is to use the available materials at the site in the most economical way. Special precautions are to be taken to see embankments are absolutely water-tight when the work is complete. Seepage water passing through and below the dam has to be reduced to the minimum possible. This is more so in case where water is stored for irrigation and for developing power. We cannot afford to lose very valuable water. This consideration dictates strict design principles and thorough construction procedure. The aim should be to construct a dam which will not only stand all the prescribed scientific tests but also serve as a model (for future reference and guidance). Quite a lot of weirs have been constructed on permeable foundations. In these cases, we are more concerned with the superstructure than anything else. We have plenty of water and we allow water to pass through foundations without affecting the stability of the superstructure. In earth dams, this should not be the case because, the cost of reducing the water lost through the dam foundation is determined somewhat by the value of the water. In any case, the loss of water through the foundation has to be reduced sufficiently to ensure the safety of the structure. A dam with reasonable water-tightness at the foundation and with the materials available at site should be built

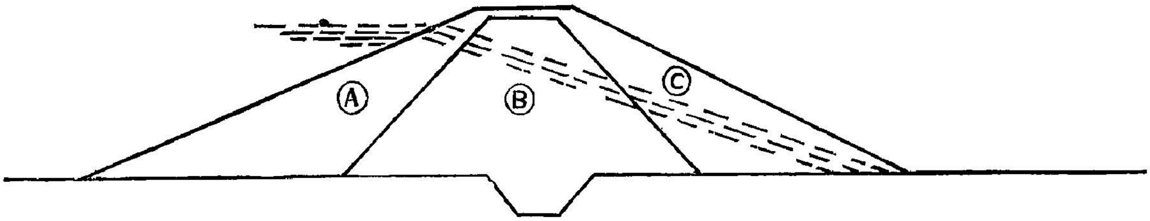


Figure 1.

Figure 1 is an example of a zoned embankment. Here, we have a central impervious core and a semi-pervious or pervious outer casing or shell on either side. The outer casings keep the inner core in place. Also, they allow the water to pass through without deterioration to the embankment. If the Central core is designed to pass a limited quantity of water then the superstructure problem is almost solved provided proper care is taken to see no piping occurs in the embankment.

Water passes through the embankment as shown by the dotted lines. (We can imagine this by comparing to water passing through small tubes). More water passes through the bottom line because the head is greater. Sum of all these lines will be the total quantity of water passing through.

Figure 2.

Water passing through the different sections A, B, C of the embankment could be compared to the flow of water through a tube of different sections shown in Figure 2.

Portions 1 and 3 correspond to the outer semi-pervious or pervious sections through which water can pass freely. The restricted Section 2 is similar to the impervious portion B of the embankment which consists of fine grained soil offering greater resistance to the passage.

The design is not complete or satisfactory, if the superstructure or embankment portion alone is dealt with. It is equally important to deal with the foundation conditions also.

Cut Off Trenches

Open cut off trenches extending to bed rocks are used where the overburden contains alluvial deposits or pervious sands and gravels and where the depth to bed rock is not very great. If the depth to the rocky or impervious strata of the foundation is not great the expense of the cut off will not be prohibitive. The open cut off trench is filled with earth in layers and compacted. This is one of the effective methods of reducing the flow of seepage water through foundations to a minimum.

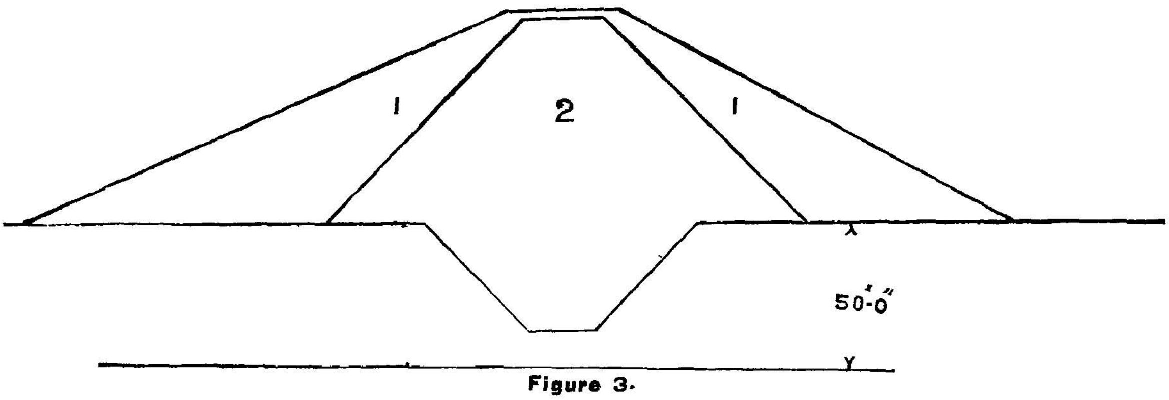


Figure 3.

The types of foundation treatments adopted are as variable as the geological conditions encountered. Top soil containing organic matter is completely removed. Shallow layers of questionable overburden are removed from beneath the impervious portion of the dam. The various types of treatment to cut off the water passing through foundations are: cut off trenches, steel sheet-piling cut off, partial cut-off, upstream blankets, core walls and cut off walls, etc.

Steel Sheet Piling Cut Off

Steel sheet piling is used in many cases where the depth to impervious strata is over 50 feet or so. In these cases, this will work out much cheaper than excavating a trench and refilling and compacting with impervious soil. The kind of steel pile section chosen is very important and depends on various factors such as boulders met with etc. However, it will not be practicable to drive steel sheet piling so

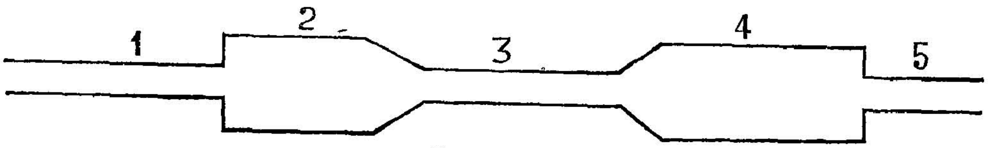


Figure 4.

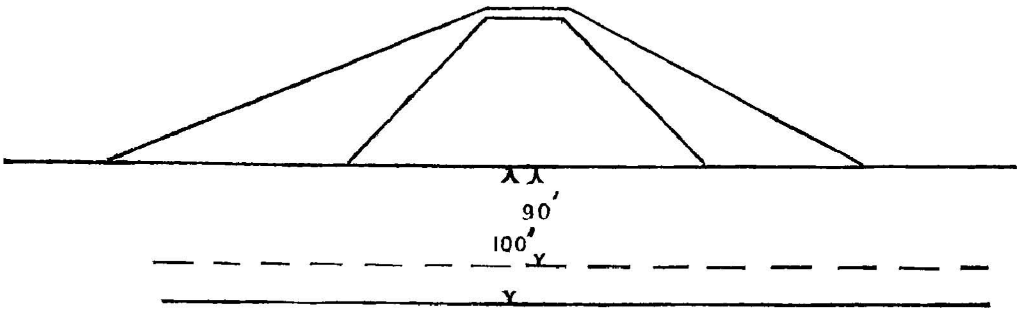


Figure 5.

that it is as water-tight as the cut-off trench of impervious material.

Partial Cut Off

Where the foundation overburden extends to great depths, only a partial cut off is used. In this case the cut off extends from the impervious portion of the dam to the underlying strata as it does not reach the impervious stratum or bed rock. Where it will be expensive and not practicable to extend the cut off to an impervious stratum, a partial cut off can be considered.

In alluvial deposits, the horizontal permeability is many times the vertical permeability and hence the effect of a partial cut off may be much greater than it might appear at first. Again, we can think of the analogy described in Fig. 2.

Consider a section shown in Fig. 3. Suppose the cut off trench is taken 40' below, 10 feet above the impervious stratum. In this case, the seepage which will take place is about 30 per cent of the seepage which would take place with no cut off wall at all. The section of the Dam is analogous to the pipe Section shown in Fig. 4.

Flow in tube 1 corresponds to the vertical and downward flow, then there is a horizontal flow and we have the restricted area 3 similar to the cut off, again a horizontal flow and finally a vertical upward flow as in the portion 5.

The discharge beneath a partly driven sheet piling or partial cut off can be easily read from the curves in Fig. 6. The discharge could be read as percentage of the discharge which would occur if there were no cut off, the material being homogenous. Suppose we have bed rock or impervious stratum of the foundation 100 feet below the ground line and that piling could be driven only upto 90 feet due to limitations.

Then from Fig. 6 using 90 per cent as ordinate we get a reading of 36 per cent. In other words the seepage will be ·36 per cent of the seepage which will take place if there were no cut off at all.

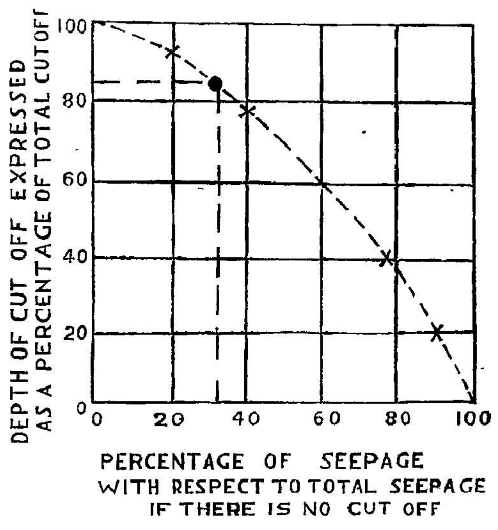


Figure 6.

Upstream Blankets

Sometimes instead of a cut off an upstream blanket is provided. This, if properly designed will increase the path of percolation thereby reducing the seepage. There are various rules and formulae enumerated in standard books for the design of the upstream blanket.

In some cases, a spread base for the dam is used, both to prevent abrupt variations in the foundations and to provide a longer percolation path. When dams are placed on clay foundations, the toe slopes both upstream and downstream are flattened. Materials used in the flattened portion of the dams are obtained from the excavations. Thus, the stability of the dam is increased and it is economical.

—"*From an Address to the Technical Club, Bhavanisagar in September 1949.*"

Desilting - Cum Reclamation of Irrigation Tanks.

By Sri U. ANANDA RAO, B.E., M.I.E., (Ind.), M.Am., Soc., C.E.,
Superintending Engineer, Food Production Circle.

Note :—Sri U. Ananda Rao has made an extensive study of the proposals during the two years he has been in-charge of Grow More Food Scheme involving large scale restoration of tanks and improving their capacity by various means. The views expressed are his observations and are published with a view to invite suggestions. The one place where the scheme suggested is adopted is in Travancore but here the soil is spread on adjacent cocoanut gardens and yielded rich returns in the shape of increased cocoanut produce.—(EDITOR.)

Synopsis: The paper traces briefly the condition of a large number of irrigation tanks in this State and suggests a practical method by which pace of further deterioration of tanks from silting can be reduced, at the same time bringing additional area under cultivation by reclaiming a portion of swampy foreshore lands with the silt excavated from the tank bed. The scheme pays for itself to some extent.

During these days of Planning, river valley projects and multipurpose schemes, any talk on minor irrigation, such as Improvements to tanks, will be the least impressive. Yet these irrigation tanks are very vital to the economic needs of villages, where they have played very important part in sustaining them. Ruin of several villages in this State could be traced to the disappearance of village tanks due to breaching or other causes and consequent economic collapse of villages and, conversely, prosperity of some villages could be solely attributed to the existence of these tanks.

2. Irrigation in this State could be broadly classified into the following four heads :-

(a) Major Irrigation - Productive - such as Godavari, Krishna and Cauvery systems. These irrigate an aggregate of 4.6 million acres.

(b) Major Irrigation - Unproductive - such as K. C. Canal, Nagavalli Project etc. They irrigate on the whole 0.35 million acres—0.314 m. acres to be exact.

(c) Minor Irrigation - mostly tanks both rainfed and riverfed through anicuts and supply channels. There are about 33,000 tanks in this State, irrigating a total area of 3.2 million acres, representing a total investment of about 200 crores of rupees at present cost.

(d) Well Irrigation—There are roughly 9 lakhs of wells irrigating about 2 million acres mainly by baling.

3. From the above, it will be seen that next to major irrigation, irrigation under tanks is important and vital both from the point of view of large extent of irrigation under them but also from the point of view of capital asset they represent. These tanks form our great heritage from the Kings of old, which we cannot afford to neglect. While major sources have been properly maintained and developed, irrigation tanks have been, in most cases, allowed to develop rather to deteriorate, as best as they could. The present condition of most of the tanks is anything but satisfactory. There is (1) heavy deposit of silt in almost all tanks, resulting in the loss of capacity ranging from 25 per cent to 60 per cent.

(2) serious encroachment into the tank bed by unauthorised cultivation further reducing useful capacity, and

(3) neglect of tank bunds, outlets and weirs to some extent. While silting is due to natural causes, the encroachment and deterioration of bunds and outlets are mainly due to lack of interest and collective effort on the part of the ryots. Maintenance by Kudimaramath work has completely disappered and factions tending to disrupt village life are on the increase.

4. Most serious danger that threatens the utility and the very life of these tanks is the rapid silting. Out of 125 tanks examined, it is seen that 13 tanks have silted more than 50 per cent 51 tanks between 25 and 50 per cent, 50 tanks between 10 and 25 per cent and 11 tanks less than 10 per cent of their capacity. Neglecting the first and the last, average silting will be about

25 per cent. Some studies on silting of Wellingdon and Mopad reservoirs were made recently and it was found that these reservoirs have also lost 12½ per cent of their capacity in 25 years. All these startling statistics reveal the woeful plight of our tanks which are a few centuries old and there is no wonder that progressive reduction of ayacut had taken place under them. Loss of capacity on the whole may be estimated at one fourth which is equivalent to complete loss of 8,250 tanks out of a total of 33,000 tanks or about 2 tanks per month for a period of 400 years. The cumulative loss of acreage due to silting may be safely estimated at 25 per cent of total registered ayacut or 8 lakhs of acres. This is a colossal loss indeed! The public and the Engineers have not yet realised fully the magnitude of the loss, the State and the public are sustaining by this process of silting. Unless some radical action is taken, it is feared that these tanks may ultimately disappear, leaving behind trails of deserts, where once tanks stood. Hence, problem of silting is not only immense but also immediate and urgent. It is not my intention to raise any unnecessary scare but to lay before you, a gathering of Engineers, a practical proposition for controlling silt for your consideration and acceptance, if found suitable. This silt problem is a challenge to Engineers, specially to Irrigation Engineers and it is worth taking up the challenge even now before it is too late.

Silting.—Before any remedy could be applied to this disease of silting, we should know the nature of the disease, and how it is contracted. Silting of tank bed is a natural process of deposition on the bed of materials transported, either as suspended matter or as bed load, by the inflow of water. These matters are the by-products of erosion of soils in the catchment, a natural process over which man has little or no control. In general, the problem is more serious in arid regions where the ground does not support a good vegetal cover; as a result, heavy rains cause excessive erosion and rapidly flowing water picks up and transports this eroded soil into tanks, where it meets stagnant water or water flowing with less velocity, with the result, silt is deposited, heavier particles first. Thus we see large deposits of heavier silt in a fan-like formation at the foreshore, gradually encroaching into the bed of the tank and at the same time lighter silt and soil depositing in the deep bed. If only we could halt the deposit of silt at the foreshore without its getting into the tank, we could have saved the tank from silting. The following four factors more or less control silting:—

(1) *Nature of catchment*.—Hard soils and soils covered with vegetal cover and grass yield less silt. Vegetation should therefore be encouraged; and any action done to soften the soils such as ploughing, burning for cultivation, should be avoided.

(2) *Slope of catchment*.—It is obvious that greater the slope of the catchment, greater will be the velocity and eroding power of running water; check dams and effective barriers across the flow of water will be useful to check the velocity.

(3) *Intensity of rainfall*.—Heavier the rain, heavier the erosion

(4) *Capacity of tank as compared with the catchment area.*

Run offs from large catchments should not at all be made to pass through small tanks. Excessive run offs should with advantage be by-passed.

Excepting factor (3), all other factors could be controlled by man to some extent and some of these are being applied to the scheme what is called "Desilting-cum-Reclamation of tanks" or D.C.R. of tanks, to be short.

6. There is no perfect remedy against silting and even if it is found, it will be a gigantic and costly task to counteract the natural processes; but we can, by determined effort, reduce the pace of deterioration. The tanks could be rejuvenated in such a way that a further useful span of life could be added to it, deriving at the same time increased benefit in the shape of extra food.

7. The following two methods are usually adopted for improving tanks:—

(*a*) Desilting of tanks—excavating from silted bed and dumping the excavated earth on the bund or elsewhere. For increasing the capacity of the tank by one m.cft. we have to carry out earth work to an extent of 1,000 units at a cost ranging between Rs. 20 and 24 per unit depending on the lead, costing between Rs. 20,000 to Rs. 25,000 on the whole. One m.cft. of additional capacity, with two fillings, can irrigate 10 acres.

Hence, cost per acre of additional area will range between Rs. 2,000 and Rs. 2,500. This is very costly. Further the problem to be tackled is where to deposit this excavated earth. It is usual to confine this kind of desilting to small tanks or ponds.

(b) Raising F.T.Ls. of tanks—Taking a medium tank of 200 acres of water spread, raising F.T.L. by one foot will give an additional capacity of 200 acre ft, or 9 m. cft, nearly. With two fillings, this additional capacity should be able to irrigate an additional area of 90 acres, provided there is sufficient yield from the catchment. From actual experience it is seen that the cost of raising F.T.Ls. varies from Rs. 103 to Rs. 563 per acre. This method is no doubt cheap, provided no valuable lands are submerged. Due to pressure on land, most of the foreshores of tanks are being cultivated with food crop and in very many cases, encroachments into tank beds have also taken place. Hence, any raising of F.T.L. will submerge large areas of cultivable lands, which not only results in the costly acquisition but also in the permanent loss of food production from those lands. In several cases examined, cost of land acquisition and other improvements was found not commensurate with the result achieved and it so happened that extra food production gained under the tank was lost in the foreshore. It was like robbing Peter and paying Paul. Hence, raising F.T.L. of tanks is limited in scope, not to speak of the inherent danger involved in raising the tank bund higher and higher every time we want to raise the F.T.L. Another great draw back in raising F.T.L. is to increase the percolation head.

8. The D.C.R. method, if adopted will go a long way towards solving the silt problem, at the same time yielding extra areas for additional production. This is a simple method, which, in essence, consists in removing silt from the bed of the tank and depositing it in shallow places at the foreshore so as to bring it above F.T.L. and at the sametime reclaiming additional valuable land for cultivation. The following sketch describes the method :—

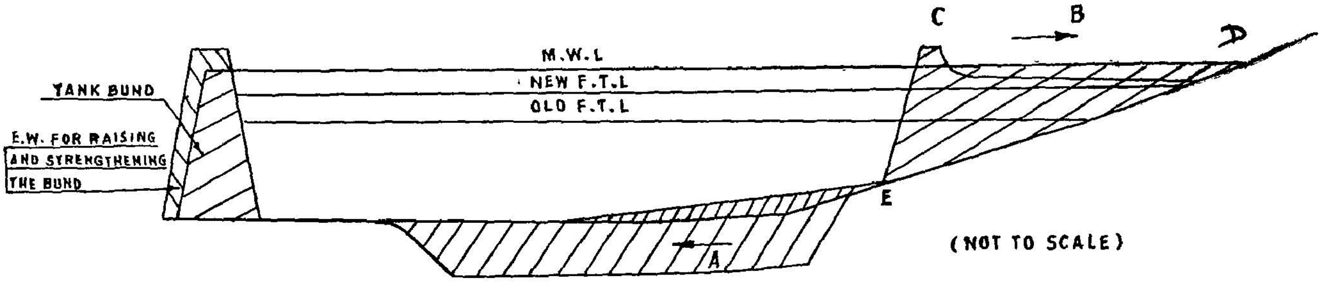


Figure 1.

Tank bed will be deepened at A and excavated silt deposited at B, where a strip of land CD is reclaimed from the tank bed ED and made useful for cultivation. A small dowel bank will be put up on the tank side so that there is no flow of water over the newly reclaimed land. A slight reverse slope to the reclaimed land also will be given This desilting-cum-reclamation method combined with raising F.T.L. a few inches will give most economical results as will be described a little later. The reclaimed lands will be very fertile, as its top will be finished with the fertile silt got from the deep bed of the tank. No ploughing or manuring is required during one or two years in the beginning. The soil will be eminently suited for raising dry crops and even wet crops under certain conditions. Shallow wells may be put in here and there to supplement the moisture in the soil whenever required. This reclaimed lands could be sold at Rs. 200 to Rs. 500 per acre thus paying partly towards the cost of work done. Hence, this scheme has the advantage of "Pay-as-you-go" and is partly self supporting.

9. The following nine advantages are claimed for this method :—

(1) This is the most economical method of desilting, and it is the only method by which

capacity of a tank, where costly lands are involved for acquisition, can be increased. The method lends itself easily to Bull Dozer and scraper treatment and hence, can be tackled quickly, cheaply and on a large scale. The scheme envisages raising of F.T.L. partly and desilting partly to make up the lost capacity. Earth work extent required to raise the bund to suit new standards will be done by hand labour and desilting with scrapers and bull dozers. There is therefore optimum economy and well balance between manual labour and machine labour.

(2) The essence of the scheme is the long range benefit conferred on the tanks by the formation of effective barriers or belts against the free flow of run off water from the catchment, thus minimising the chances of further silting of the tanks. This means prolonging of the life of the tanks indefinitely. If we examine the tank bed and its F.T.L. contour, its water spread area will be more or less as shown below :—

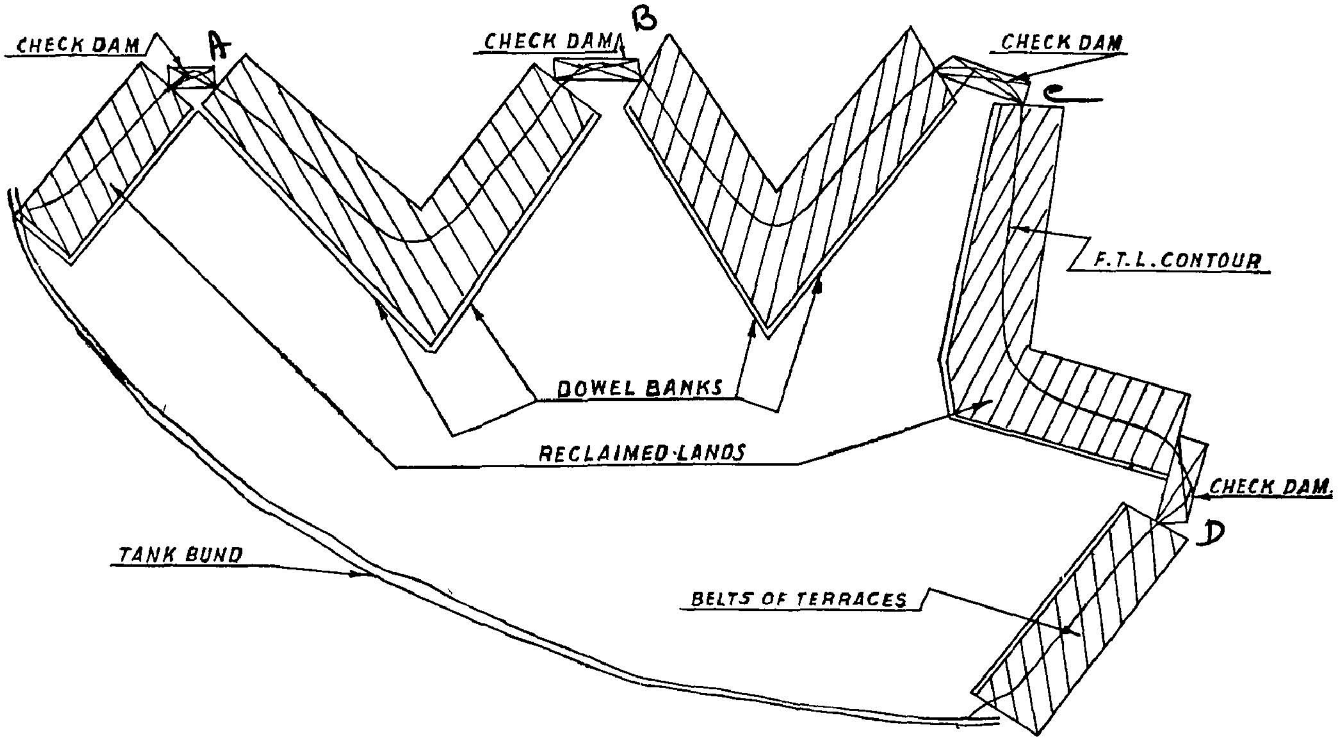


Figure 2.

Run off water from the catchment will generally be entering the tank at flanks or through valleys marked A,B,C,D in the sketch, though during heavy rains, water will be entering the tank from all directions bringing down lot of silt. In the D C.R. scheme, blocks of reclaimed lands will be formed at the foreshore so as to form effective barriers leaving suitable gaps between them, as marked A,B, C and D. These gaps could be localised and effectively controlled with series of check dams, encouraging the deposit of silt just above the check dams and not in the tank bed. As dowel banks will be put in all round the reclaimed blocks, there will not be any direct run off from this area. A few pipes or roughstone drops will be provided here and there to drain water as is done in the case of contour bunds. These reclaimed lands along F.T.L. contour serve the same purpose as contour bunds.

(3) Vast areas of tank beds which remain now as swamps, or waste can be reclaimed and cultivated with food crops. Assuming we reclaim a minimum of 5 acres from small tanks and 20 acres from large tanks, we can easily get 3 to 4 lakhs of acres under all 33,000 tanks of this State. This is in addition to the extra areas, that will be obtained under the tanks consequent to the increase in the capacities of the tanks. This

area may be put roughly at four lakhs as mentioned in para 4 above. This would add considerably to the food position of the State and to the easing of tension of unemployment amongst the landless poor.

(4) Total area of water spread exposed to sun is reduced, thus reducing loss of water from evaporation.

(5) By excavating at suitable places, spring heads could be exposed. At present, they are buried without use to anybody.

(6) Marginal swampy areas are reclaimed and made more sanitary and healthy.

(7) The scheme pays for itself to some extent from the sale of reclaimed lands at the foreshore. It is understood that if foreshore lands are granted free to some interested ryots, they themselves may reclaim those lands to suitable level free of cost to Government. If so it would amount to two birds at one shot.

(8) This work increases flood absorbing capacity of the tank, by holding up water above the check dams for some time.

(9) Unauthorised cultivation in the foreshore could be put under firm footing, thus ensuring fixity of tenure to the cultivators with consequent increase in food production.

Only disadvantage is, as far as I can foresee, the initial capital outlay and high maintenance charges for some time to come. The latter can be eliminated if we can get full co-operation from the foreshore ryots. Consent of the foreshore ryots is quite necessary to encroach on their lands and raise their levels.

(10) The following tanks were analysed to find the economics of various proposals:—

(i) Aghraharam Eri of Devamur village of South Arcot Dt.

(ii) Dharmacheruvu of Muchanapalli village of Tiruvur Taluk, Kistna District.

(iii) Ura tank of Gollamandala village of Tiruvur Taluk, Kistna District.

(iv) Prina tank of Tsanubanda village of Tiruvur Taluk Kistna District.

I shall, however, explain the details of two typical cases:—

	Aghraharam Eri of Devamur village of Gingee Taluk, South Arcot District.	Prina tank of Tsanubanda village Tiruvur Taluk, Kistna District.
1. Registered ayacut	165 acres	120 acres
2. Average Cultivation	138 ,,	55 ,,
3. Gap	27 ,,	65 ,,
4. Existing capacity	9.01 M. Cft.	5.55 M. Cft.
5. Proposed capacity required to irrigate whole of registered ayacut.	13.71 M. Cft. Duty 6 acres per m. cft. with two fillings.	8.55 M Cft. Duty 7 acres per m. cft. with two fillings.
6. Balance of capacity to be made good	4.7 M. Cft.	3.0 M. Cft.
7. Cost for excavating this quantity	Rs 71,700	Rs. 45,000
8. Additional area that can be reclaimed with this earth	19 acres	25 acres
9. Total additional area	27 plus 19 or 46	65 plus 25 or 90 acres
10. Cost per acre.	Rs. 1,559	Rs. 500
	Raise F.T.L. by 1'-0"	*Raise F.T.L. by 0'-6"*
Increase in capacity by raising F.T.L.	2.07 M. Cft.	0 85 M. Cft.
,, desilting	2.63 M. Cft.	2.15 ,,
Cost	Rs. 42,350	Rs. 39,250
Total additional area	27 plus 23 or 50	65 plus 29 or 94
Cost per acre.	Rs. 847	Rs. 420

	Aghrabaram Eri of Devamur village of Gingee Taluk, South Arcot District.	Prina tank of Tsanubanda village Tiruvur Taluk, Kistna District.
	Raise F. T. L. by 1'-6"	*Raise F. T. L. by 1'*
Increase in capacity by raising F. T. L.	3.11 M. cft.	1.80 M. Cft.
desilting	1.59 "	1.20 "
Cost	Rs. 29,250	Rs. 26,400
Total area	27 plus 23 or 50	65 plus 21 or 86
Cost per acre.	Rs. 585	Rs. 308
	F. T. L. raised by 2'-0"	*F.T.L. raised by 1'-6"*
Capacity got by raising F.T.L.	4.70 M. Cft.	3,00 M. Cft.
Cost	Rs. 25,000 including cost of Rs. 8,000 towards acquisition of 16 acres.	Rs. 41,400 including a sum of Rs. 25,000 being the cost of 10.8 acres. of foreshore lands liable for submersion.
Area	27 — 8 or 19	65 — 10.8 or 54.2 acres
Cost per acre.	Rs. 1,300	Rs. 765.

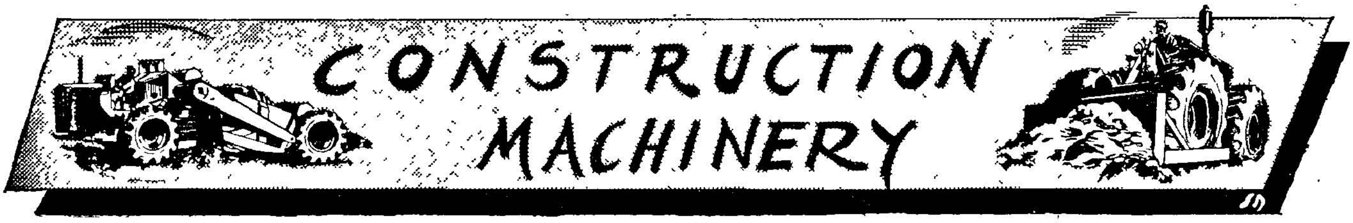
The cost per acre of additional area under D. C. R. when combined with raising F.T.L. to some extent, is cheapest and is somewhere around Rs. 300 to Rs. 400 per acre. This amount could be cut down to half if scrapers and other mechanical appliances are used. This is far cheaper than the cost per acre under Major Projects. An acre under Lower Bhavani Project and Tungabhadra costs about Rs. 600 while Manimuthar and similar projects cost anywhere between Rs. 1,000 and Rs. 2,000.

—Based on a paper read by the author before the Institution of Engineers, Madras Centre on 28-3-'53.

HOW WOULD YOU DO IT?

Solution to Problem on Page 4

The cross-grained blocking at the ends of the columns had gradually squeezed down, (wood being much weaker in compression transverse to the grain than longitudinal to it), and cumulative settlement over several of the floors became serious. The solution to the problem was simply to jack up the columns and replace the blocking with metal plates.



Tips on the use and care of your lifting jacks.

Synopsis

'Know How' of construction equipment and operations always results in economy and longer service life of machinery. This is true especially with smaller tools and accessories rather than with big machines which may not be so frequently used. In the following article, use and care of lifting jacks has been dealt with, which hints at wrong usuage in some places resulting in lesser efficiency. Tips on safety and maintenance are also underlined.

Basically the following five types of jacks cover the entire field: (1) Ratchet (2) Screw (3) Hydraulic (4) Air motor power and (5) Miscellaneous jacking mechanisms. Each one is dealt with below:

Ratchet Jacks: This is the simplest in the construction field based on the principle of liver and-fulcrum to lift and lower the load. Single acting and double acting jacks are also common here. In the single acting type the downward stroke of the lever raises the rack one notch. The load is held in position by a pawl fulcrumed in the base. Double acting ones are those which raise the load both during downward and upward strokes. This type requires more manual effort due to location of pawl fulcrums. The chief advantage in this type is faster operation on lighter loads. Lowering mechanism in the ratchet jacks are of 2 types: (1) automatic or ratchet lowering and (2) trip lowering. In the first one, the load is lowered one notch at a time whereas in the latter it is dropped instantly. Hence the latter is used for track work only, the former being used for lifting machinery.

Among the many applications of ratchet jacks in the construction field are, lifting equipment into place, moving and setting heavy machinery, repairing construction equipment, breaking seals on manholes and lifting and holding light structures. These are built in 5, 10, 15 and 20 ton sizes of various heights for different industries. Wearing parts are pawls, the rack teeth and fulcrum points. Care should be taken to see that the pawls engage rack fully at the end of each stroke and also that the rack and teeth are in good condition.

Screw Jacks:—The principle employed is that of a screw-and-nut in regular and inverted designs. In the regular type the load is lifted by the screw raising the jack housing whereas in the inverted type the screw remains fixed riding on ball bearing at the back of jack housing. A lever bar, various gears and ratchet devices are employed for lifting different loads. Geared screw type usually range for lifting loads from 5 to 100 tons. Foot-lifts in this type can be used under loads as low as 7″ in height. Heavy loads can be lifted and held in position for long periods. Gear screw racks are usually used for rigging, general heavy lifting for bridge and structural steel erection, and other steel erection jobs. Journal type of screw jacks are particularly useful in bridge, concrete forms and in places where low height is required. These types though costlier than Ratchet jacks have lower maintenance cost, easy of operation and a great deal safer to operate than the rack jacks.

Hydraulic Jacks:—Versatility in service is the keynote of these types and the capacity ranges from 3 to 12 tons. In all these the oil is

sealed in a reservoir which drains into a pump passage from where it is pumped under the ram to raise the load. It is most important when placing these jacks in position to move a load, that it be placed so that the oil can drain by gravity to the pump. The 20 to 100 ton jacks do not have extension screws but pumps are incorporated in some models one for speed and the other for high pressure. Jacks in which the pump with the reservoir is a separate unit from the ram, can be placed in any position.

Air Motor Power Jacks:—These are relatively of recent development and loads up to 100 tons can be lifted without effort by means of a self-contained air-motor. The ratio of air motor power versus hand jacking was one to nine and operator fatigue factor is completely eliminated. Jack capacities should be selected to match the load to be lifted to obtain most satisfactory and economic results.

Through the use of a connecting air-hose two jacks of the same capacity can be used by one man when it is required to lift or lower two ends of heavy structures evenly and smoothly. These have been used with success on raising bridges, pushing heavy pipe and in locomotive repair shops. Geared screw jacks are precision tools, in which all parts are operated in good grade of grease within a closed jack housing. Exposed outside parts should always be kept clean and lubricated.

Special Jacks:—TRENCH BRACES—Jacks used on this work proved essential to the safety of workmen on excavating jobs. This type is essentially a screw type jack mounted on either end of a piece of pipe or timber with ball and socket joints at either end permitting adjustment to any angle. Complete units in closed length from 16″ to 60″ with screw lengths 10″ to 18″ which can extend from 6″ to 10″ are available.

PUSH AND PULL JACKS:—Composed basically of 3 elements: (1) a long threaded screw (2) a ratchet mechanism mounted in middle and (3) two steel nut like devices for push and pull operations. Available in rated capacities upto 15 tons. Uses are tying piling and bents on cofferdams, bridge and dock construction, straightening shovel dippers, truck frames and other damaged structures, erecting bridges and trestles etc.

Maintenance and Safety Tips

1 Right type of jack and sufficient supply on hand are important. A 10 ton jack may lift 13 ton but risk to equipment and personnel is not worth taking the chance.

2 Storage place for jacks not in use, and painting them for quick indentification are essential.

3 Do not use defective or unsuitable jacks or handles.

4 Don't allow incompetent men to handle jacks.

5 Avoid overstrain of jacks (i.e.) load should not be heavier than rated capacity.

6 When using foot lift, place the lifting toe all the way and squarely under load.

7 Jacks should be centred, plumbed and properly blocked. Base should always rest on an even unyielding surface. Don't jack against steel. Always use a wood stem. Always block it as closely as possible to the load to obtain maximum lift.

8 To prevent sudden dropping in case the jack is accidentally jarred or tripped blocking is essential.

9 Remove handle from jack after a lift to avoid stumbling by men.

10 Always have the jack set for lifting so that when the lever is moved accidentally, jack will only raise instead of lower.

11 Regular oiling of jacks at least once a month will pay in the long run.

12 Hydraulic jacks should always be set in an upright position even when not in use to avoid oil leakage or air from getting into the jack.

—Condensed from an article in 'Western Construction', October, 1952.

Progress of Research Work in Madras

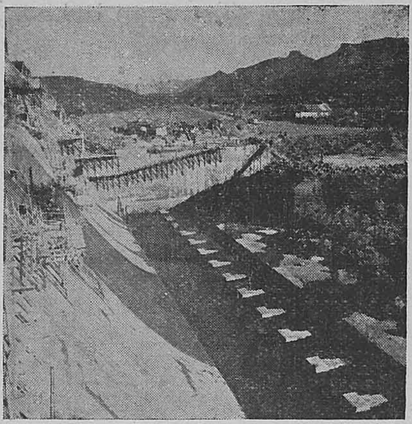
A. Irrigation Research Station, Poondi, Madras (1944-52)

(Continued from previous issue)

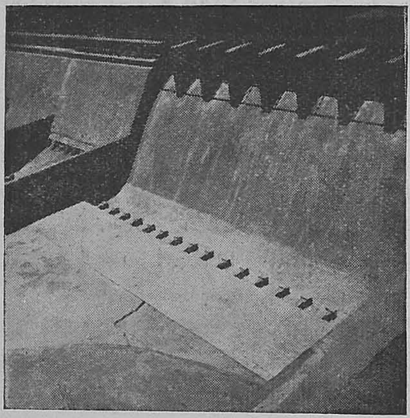
5. Outstanding Work Done So Far

The following are a few examples of the important studies conducted in the Research Station.

(1) *Stilling Basin with Tee-blocks* :—In the course of carrying out studies for the design of energy dissipation arrangements for the Lower Bhavani spillway dam a new device has been evolved which consists of a stilling basin with Tee shaped blocks inside it and a short apron beyond. By locating the blocks inside the basin instead on the apron downstream as in the conventional designs the length of the aprons is reduced. The device ensures the creation of a hydraulic jump which reduces the velocity of flow even for very low tail-water levels and at the same time the stream has no diving characteristics so that the depth of scour is low. This arrangement is found to be very efficient and economical and has been adopted in the Lower Bhavani Dam. This principle has also been applied successfully in a number of subsequent designs including those for anicuts.

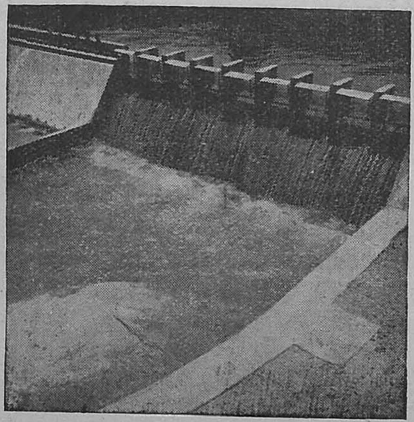


Lower Bhavani Dam—Spillway dam in nature showing stilling basin with the blocks

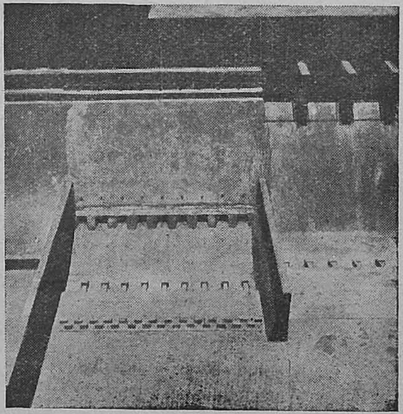


Lower Bhavani Spillway Dam—Model with stilling basin dry

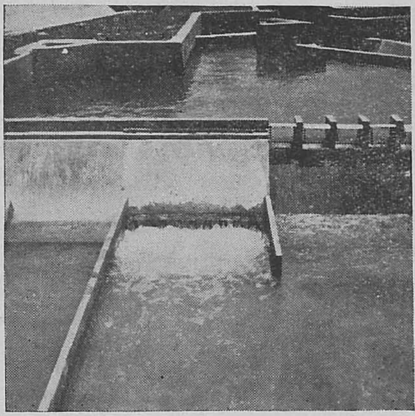
(2) *The Design of Sluices in Dams* :—The design of river and canal sluices in Lower Bhavani dam was subjected to a through investigation by hydraulic models and a very efficient design was evolved. The design as finalised consisted of an inlet built up of elliptical curves ensuring cavitation-free operation. Studies also included determination of discharge co-efficient



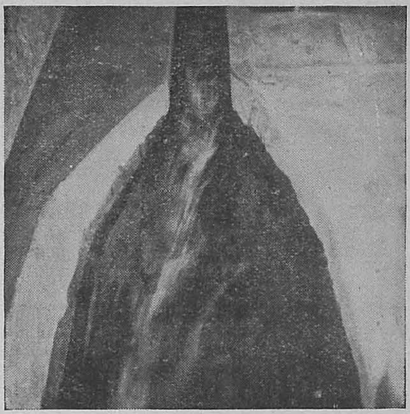
Lower Bhavani Spillway Dam—Model functioning under flood discharge



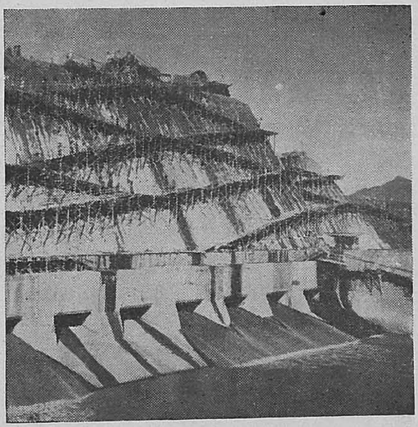
Lower Bhavani Dam—River Sluices—Model Dry



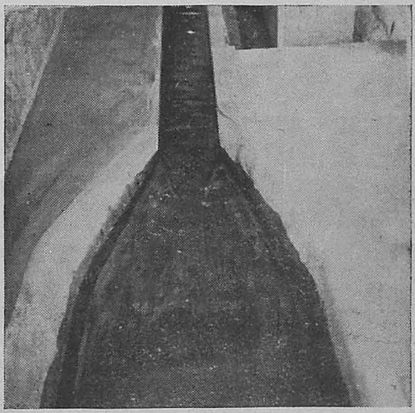
Lower Bhavani Dam – River Sluices – Model functioning under maximum discharge



Exit transition showing uneven flow with no rectifying device



Lower Bhavani Dam – River Sluices – Structure in nature showing the fanning out of jets

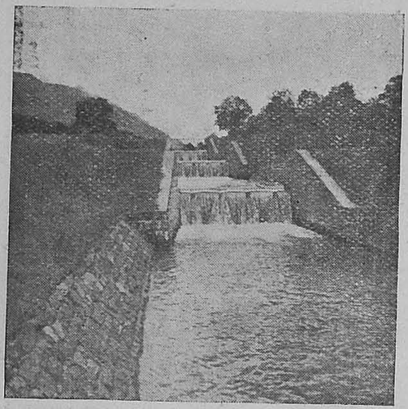


Exit transition with deflector vanes beyond throat restoring quiscent flow

for the sluices. The energy dissipation arrangements consisted of a stilling basin with T shaped blocks in it as in the case of the spillway dam.

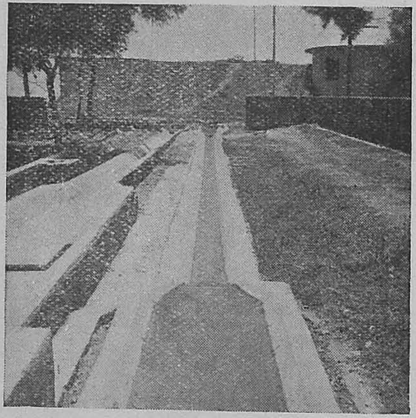
(3) *Design of Exit Transitions in Aqueducts*:—The width of a stream is sometimes reduced at an aqueduct to effect savings in cost. But at the exit end, the stream is made to connect up with the normal dimensions of the channel through a transition. In the design of exit transition in cross-drainage works, the high velocity stream from the flumed portion issued centrally in the transition region, giving rise to eddying and uneven velocity distribution, resulting in increased head loss in the structure and objectionable scouring action on the bed and sides. The conventional practice consists of providing long exit transitions of 1 in 5 to 1 in 10 divergence to restore normal conditions of flow downstream of the flume portion. As a result of basic studies conducted on the subject a device was evolved in which only a short transition of 1 in 4 divergence in plan, was adopted but two submerged deflecting vanes of triangular shape or an obstruction called a bed deflector sill were employed so as to restrict the flow in the centre and induce greater flow towards the sides. The financial benefits of these devices cannot be overstated for they will be of help in the design of several cross drainage works in future projects.

(4) *Lined Canal Chutes in lieu of Drops*:—In certain reaches of the distributaries of the Lower Bhavani Project, the ground fall is very steep, being in the order of 1/50 to 1/100 thereby necessitating the construction of a series of drops in short reaches.

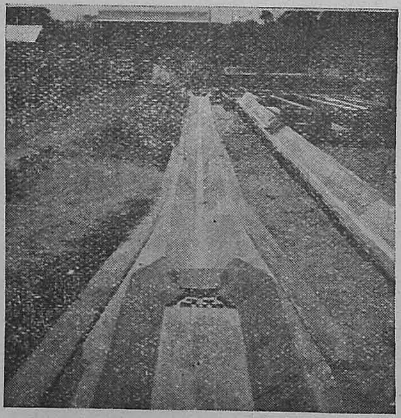


Example oi a series of drops in a steep reach

The above figure illustrates a steep reach where a number of drops were used though it does not relate to the Lower Bhavani Project. In such situations, designs have been evolved for lined canal chutes in lieu of drops, in which the bed fall of the chute approximates to the existing ground slopes, a velocity of about 20 feet/sec. being permitted in the chute portion. In the chute, inlet transitions straight in plan were found to be adequate, but at the exit end energy dissipation arrangements had to be provided and in this connection a very efficient device consisting of a deflecting roof to be constructed in reinforced concrete in the prototype was developed for the purpose. The adoption of chutes in lieu of the drops in Lower Bhavani Project, resulted in savings in cost to the extent of about 40 per cent in the reaches concerned.

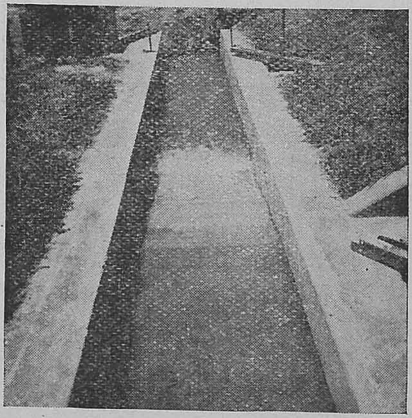


Lined Canal Chute looking downstream



Lined Canal Chute looking upstream showing stilling basin

(5) *Co-efficient of Discharge of River Weirs* :— The studies conducted on the Kistna anicut at Vijayawada revealed, that the computation procedure till now in adoption did not furnish a correct estimate of the discharge for all conditions of flow, and that errors to the extent of even 30 per cent may result for certain conditions of flow. The important findings were that a weir does not really get submerged although tail water may rise above the crest, until certain depth of overflow was attained. Furthermore, it was observed that even when a weir really got submerged owing to a sufficiently high tail-water, the discharge computed on the assumption of

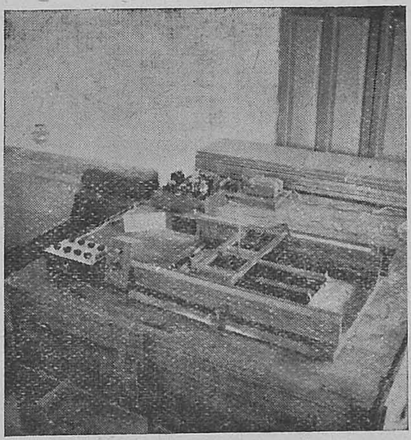


Sangam anicut—functioning as a free over fall weir though rear water level exceeds crest elevation

free overfall, will not vitiate the result very much contrary to the normal belief. In the light of these facts experiments were carried out for estimating the discharge precisely over the major anicuts in the state such as the Godavari, Nellore and Sangam since the results of discharge computation are of particular value in the design of projects. Studies on other important anicuts are also in progress.

(6) *Sheet Pile cut-off in Earth Dams* :—With a view to reduce the seepage loss underneath an earth dam, and prevent occurrence of sand boiling or quick sand phenomenon, as it is called, at the toe which endangers the stability of the rear slope, experiments of a basic nature were conducted on seepage models inside glass tanks employing dyes for tracing the path of stream lines. The efficacy of steel sheet-piling driven partially into the pervious substratum and the use of clay blanklets on the upstream were examined and the optimum proportions for the same determined. The results will be of general application in the design of high embankments and earth dams.

(7) *Infiltration Galleries* :—In the design of infiltration galleries for water supply schemes, there are a number of uncertain factors and it is not unusual that, some of the galleries fail by chocking after a time. For studying this problem

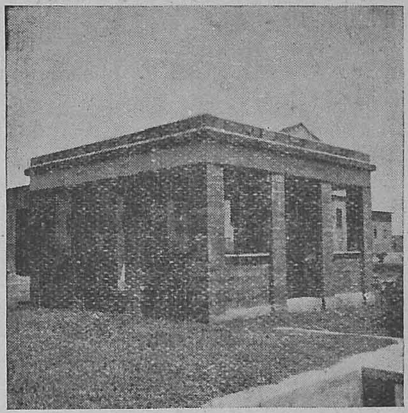


Electrical Analogy Set up

use was made of the fact that the law of flow of water through sand, is similar to the law of flow of electricity through conductors, and a standard technique, known as the Electrical Analogy technique was adopted, for the purpose. As a result of these experiments a number of useful results were deduced which served to evolve a rational procedure for the design of galleries in the future.

(8) *Materials Research* :—The activities of the Poondi Research Station are not confined to hydraulic model experimentation only, but investigations on building materials are also conducted with a view to,

(i) evolve economical substitutes for conventional building materials such as bricks and cement,



Soil Cement Pavilion

(ii) find out suitable materials for low cost temporary housing for use in projects,

(iii) employ the materials available close to the construction site with necessary improvements, as to effect savings in cost and also expediate speed of execution. A result of studies conducted in the station, it was noticed that soil-cement blocks built of redsandy loam available at Poondi containing about 70 per cent sand and 30 per cent clay and admixture of 8 per cent of cement by volume of soil, were equivalent in strength to brick-masonry for housing purposes, and about 30 per cent cheaper. Soil-cement blocks were extensively used for the construction of buildings in the Lower Bhavani Project where they were partially beneficial besides effecting savings in cost since suitable soil for manufacturing bricks was not locally available, and the procurable soil was good for manufacture of soil-cement blocks.

6. Staff.

Administrative Control and Technical Direction.

Sri L. Venkatakrishna Ayyar, B.A., B.E., I.S.E.,
Chief Engineer for Irrigation,
Madras Public Works Department.

1. Research Executive Engineer: Sri J. Visveswara Rao, B.E., M.S.C. A.M.I. Struct. E. (Lond.) Assoc. M. ASCE, A.M. I.E. (Ind).
2. Assistant Engineer: Sri N. Muthukrishnan, B.E., A.M. I.E., (Ind).,
3. Assistant Research Officer: Sri T. Srinivasa Mudali, B.A. B.E.

4. Junior Engineers: (1) Sri B.A. Rahman.
(2) Sri A. Lakshmanaswamy, B.E.,
(3) Sri Mohamed Sanaullah, B.E.,
(4) Sri S. Amalorpavam, B.A. B.E,
(5) Sri R. Govinda Menon, B.E.,

Junior Engineer: (Lower Bhavani Project.) (1) Sri P. Ramanarayanan, B.E.,

Junior Engineer: (Kistna Pennar Project) (2) Sri P. Kumaraswamy, B.E.,

Supervisor—Works: Sri P. Lakshminarayana.

Supervisor—Designs: Sri A. V. Ramaswamy.

The spirit pervading among the staff may best be described in the words of Lin-Yutang, Chinese author from New York who once remarked "There is nobody in the world who loves his own work except a Research Worker"

APPENDIX

How to Reach the Irrigation Research Station, Poondi ?

Poondi may be easily reached by several methods of conveyance viz.,

(i) by car or special buses;

(ii) by service bus; and

(iii) by train up to Trivellore and then by buses or jutkas.

Hints are furnished below for the guidance of visitors using the different modes of transport.

1. By Car

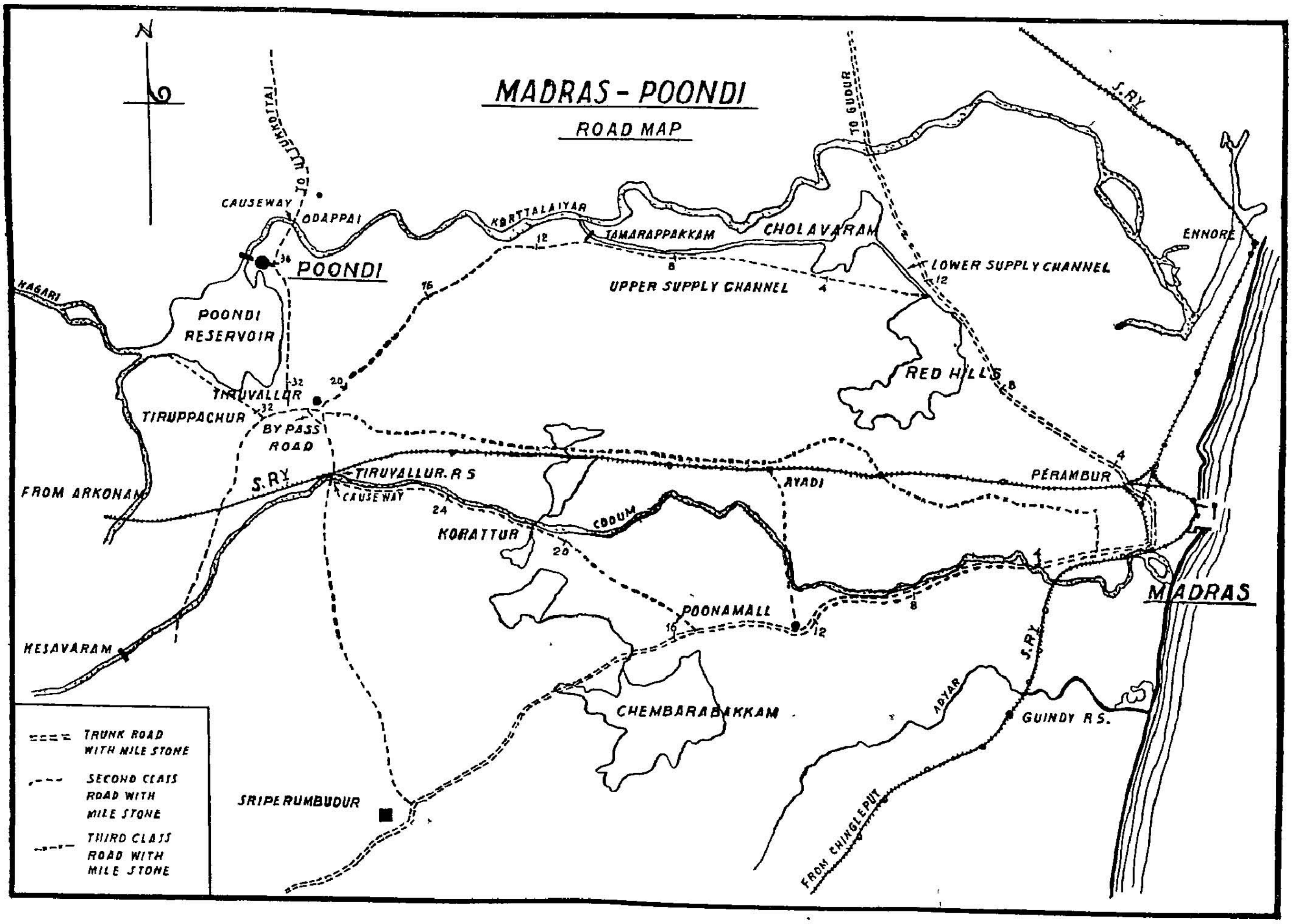
There are three routes by which visitors may drive to Poondi which may be described as

(i) the Poonamalle route;

(ii) the Red Hills route; and

(iii) the Avadi route.

Among these the Poonamalle route has the best road and hence it may be preferred to the



other two unless one is interested to visit Red Hills or Avadi in the way as the case may be.

(i) *Poonamalle route.*—In following this route one drives along the trunk road from Madras to Poonamalle till mile 15/3 and then shifts on to the branch road taking off to the right at this place. This branch road passes through the village of Korattur, and crosses the Cooum River over a causeway at Trivellore Railway Station and the railway line through a level crossing immediately beyond. In driving along this road it leads to the Trivellore Town which is 2 miles from the Railway Station. Just before entering the Trivellore town, however, the by-pass road to the left may be taken which meets the main road from Trivellore town to Tirupachur below. On reaching this junction and driving towards Tirupachur for a short distance, beyond the 31st mile a branch road takes off to the right towards Uttukottai which should be followed. In driving along this road beyond the 35th mile a branch road takes off towards the left leading to the Regulator which is 1 mile 3 furlongs from this point. There is a well furnished Inspection Bungalow with two suites at Poondi which may be available for occupation of visitors by applying for reservation in advance, to the Research Executive Engineer, who is also in charge of the Irrigation Research Station.

(ii) In taking the Red Hills route, one has to drive along the trunk road from Madras to Gudur till the 11th mile beyond which the branch road taking off to the left will have to be followed. This road leads straight to Trivellore town from where the main road leading to Tirupachur may be followed until the branch road taking o ffon the right to Uttukottai is met. After taking the road leading to Uttukottai, the rest of the journey may be performed as indicated previously.

(iii) If one wants to take the Avadi route, the trunk road from Madras to Poonamalle will have to be followed up to Kilpauk where the branch road leading to Trivellore takes off on the right as indicated in the road map. After reaching Trivellore the directions as indicated in (ii) above may be followed.

2. By Bus

There are service buses connecting Madras and Poondi which follow the Red-Hills route. They leave Madras at the muffusil bus stand behind the Corporation Fruit Market.

The tentative schedule of timings for to and fro services is given below :

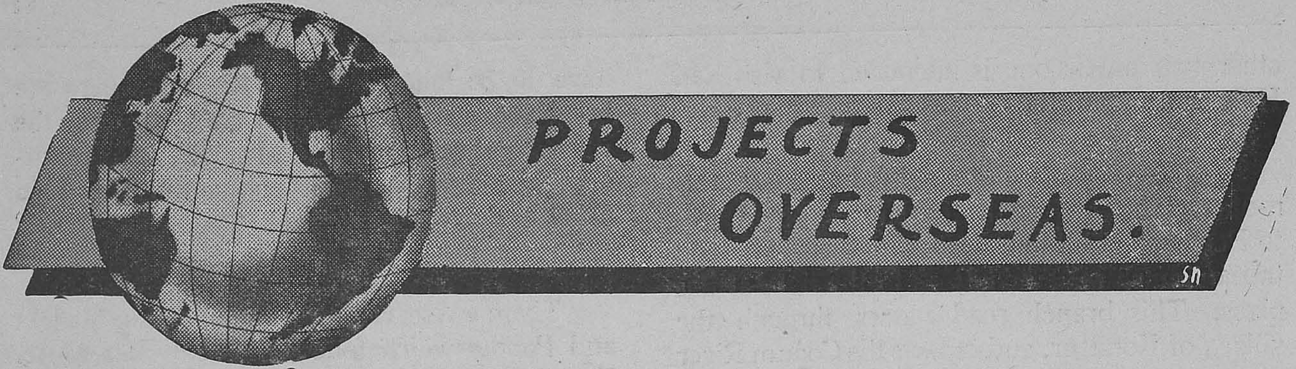
No.	Leave Madras.	Reach Poondi.	Leave Poondi.	Reach Madras.
1	5-30 A.M.	7-45 A.M.	5-15 A.M.	8 A.M.
2	8.45 A.M.	11-30 A.M.	7-45 A.M	10-30 A.M.
3	11-15 A.M.	2-00 P.M.	8-45 A.M.	11-00 A.M.
4	12-30 P.M.	2-45 P.M.	12-15 P.M.	3-00 P.M.
5	3-45 P.M.	6-30 P.M.	2-45 P.M.	5-45 P.M.
6	6-15 P.M.	9-00 P.M.	3-45 P.M.	6-00 P.M.

It may be noted that apart from above, a number of other buses ply on the route described earlier as the Poonamalle route. But these buses run on the Trivellore to Uttukottai road without following the branch road to the Regulator beyond the 35th mile. Hence passengers taking these buses will have to walk about a mile to reach the Regulator and the Research Station.

3. By Train

There are a number of locals and passenger trains between Madras Central and Trivellore. After reaching Trivellore Railway Station one may reach Poondi by engaging jutkas which will be available. Otherwise, one may reach Trivellore town first in a bus, since a shuttle bus service is run between Trivellore Railway Station and the town. On reaching Trivellore town, the journey may be resumed in one of the buses whose routes have already been described.

(*Concluded.*)



First Austrian Submersible Power Plant.

Submerged plants have proven their feasibility, according to this summary, their chief advantage being their ability to function at times of low stream flow.

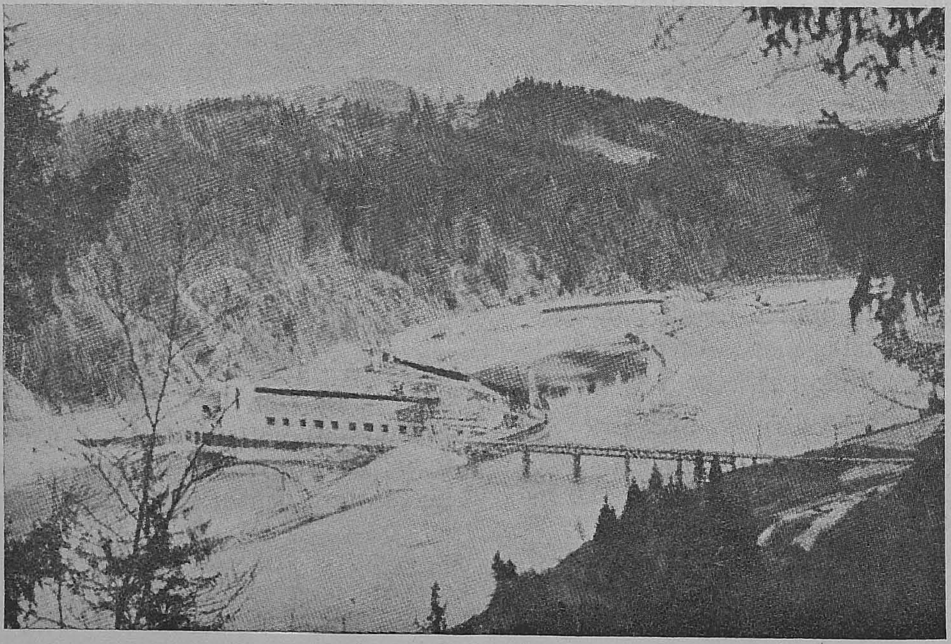
The idea of lowering an electrical power plant, at least in part, below the river's surface, is approximately 20 years old. It comes from Germany, where it was executed in practical form at about 20 plants, housing 70 turbine—generator sets varying in power from 1,700 to 2,500 H.P.

The basic idea of building such a type of power plant is the use of river water of an ordinary rate of flow through all stages of water level from low to high. While the conventional type power plant often suffers from low output at extremely low water levels, as well as at times of floods, the new SUBMERSIBLE type is able to turn out an equal amount of electricity under almost all stream conditions.

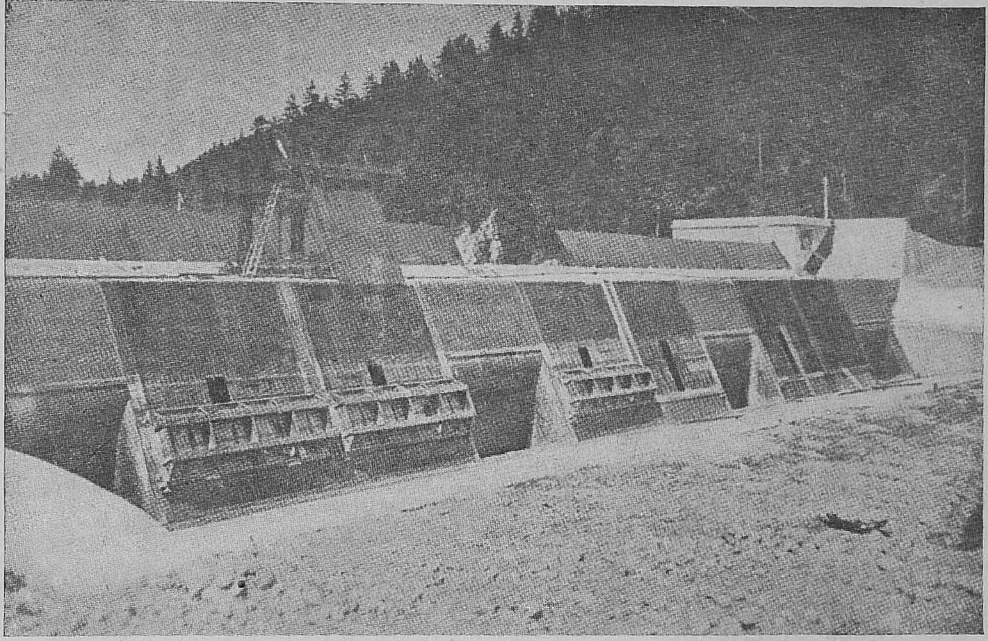
In mountainous regions, this type of electricity production has already been able to take over the major role in production. The decision as to the kind of power plant suited to such regions is quite clearly favourable to the submersible type.

In flat areas, however, use of this type of plant is at present a border-line question, dependent finally on the amount and angle of gradient of the flow.

It is necessary to install a higher number of generator sets in a submersible power plant



General view of completed plant. Four blind tubes flank three pairs of work tubes at the Lech plant. Note temporary dams.



Structural details of dam, showing the various tubes, emergency locks and other features.

because of the wider channel but diminished pressure of the water supply. The generators are also, therefore, smaller in their output of power. The chief advantage is that no pipe system is necessary to direct, collect, or regulate the water.

Such a submersible electric power plant consists basically of a river-wide dam, up to 60 feet high, depending on the water level. The dam, anchored in the river banks and usually founded on concrete or steel piles, houses the work tubes, blind tubes (which allow direct flow through the dam), and dam-width machinery housing. On top of the dam, crest gates are mounted, designed to store water in times of low natural supply. They can, in periods of high water, be set at a zero angle and the entire dam can be flooded over.

Study of the water draft in the river in question determines the arrangement of work tubes and blind tubes in the various plants: whether the work tubes shall be concentrated in the river's centre or located nearer to each bank. Usually, blind tubes are located near the river bank, with a work tube alongside, then a blind tube again, while the centre itself is a work tube.

The location of the machinery housings differs also. Most often built on top of the tubes, with small chambers beneath the turbines (for oil changes and control of the lower sections of the generators), there are some plants which place the machinery chambers as low as the turbines. The turbines are then led through the machinery housing and all maintenance and control work can be done without shutting off the turbine action.

The previously-described parts are all installed under the water's surface, or they can be flooded over at will. Only the main control house is above surface, housing all switches and controls for the delivery of electrical energy. It is, except for the rear of the dam, the only visible part of the whole power plant.

The Machinery

Machinery used for the submersible power plants consists essentially of watertight turbo-generator units, mounted inside the work tubes. In order to establish a better water pressure, a slight deviation is formed in the tube, and the unit installed at the bend, or just before.

Basically, two different types of generators are used: the first is the water-sealed unit, an egg-shaped generator anchored with four stream-lined piles on the tube's wall. Toward the water's inlet, a turbine wheel with pre-set blades, three to six blades per generator, is mounted and

turned at about 200 to 250 rpm. A safety rate is allowed for, up to 470 rpm. One of the piles on which the unit is mounted houses the electric wires, the oil supply line, and the control devices for oil pressure, bearing temperature, and oil flow. In this generator type, the regulators are located in the machinery housing, together with the mechanical, hydraulic, and electrical devices for operating the throttle control, the rear tube sealing, and the crest gate.

The newest type of unit is the Kaplan turbine, with its main advantage, the ability of changing the set of the blades' angles while the turbine is in action. Three to twelve blades can be changed to any desired angle, to meet any changes in water pressure and volume, as well as in speeding up or slowing down the turbines' rpm number, and with it, its output of electrical energy.

The Tubes Described

As previously mentioned, there are sensitive throttle controls at the work tube's front end, mechanically, hydraulically or electrically operated. The amount of water must be very closely regulated, and for periods of repair, etc., the valve can be locked so as to be completely watertight. Behind the set, steel plates are mounted parallel to the closed front throttle. The plates, mechanically lowered, permit all maintenance work on the machinery sets; they are mounted in rails located in the tube walls, and seal the tube watertight from the lower water section at the rear.

For most types of tubes, small chambers are built underneath the work tubes. They house the sump pumps and oil cleaner, and serve for inspection of the Kaplan-type turbines. In front of the tubes, narrow but strong steel rakes are mounted, designed to remove from the water all such debris as stones, boulders, wood etc., before it enters the tube.

The blind tubes are located somewhat lower than the work tubes, and are able to take a large amount of water. The blind tubes have, as their only mechanical device, front valves which sensitively control the amount of water above the dam.

Three groups of units are located inside the machinery housing. First is the electrical group, which consists of a transformer for each generator. The transformer is a set made up of A.C. motor of 25 to 30 kw, turning at 1,500 rpm, one D.C. generator of 18 to 22 kw, and a flywheel of 120 kgm.[2] (The transformer data are for generators of approximately 1,500-H.P. output).

The second group is the control device for the turbine-generator unit. It has armatures for oil flow and oil pressure, and a thermometer for the bearing temperature. Light signals show the valve setting and the positions of the turbine-wheel blades.

The third group is the machine set which operates crest-gates, throttle valves and rear-tube valves. All settings and operations are effected by mechanical, hydraulic, and electrical devices.

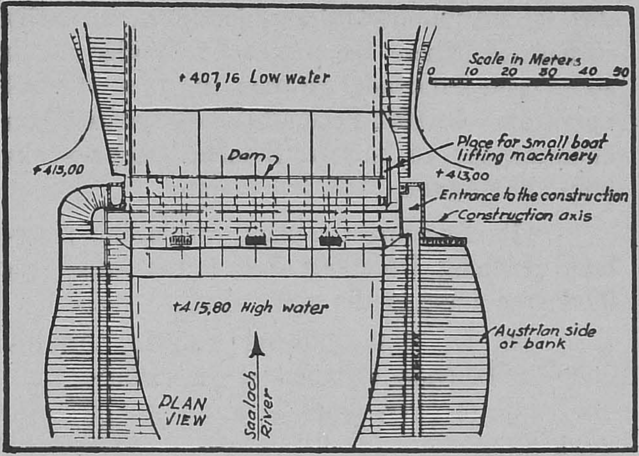
Plan Fully Automatic

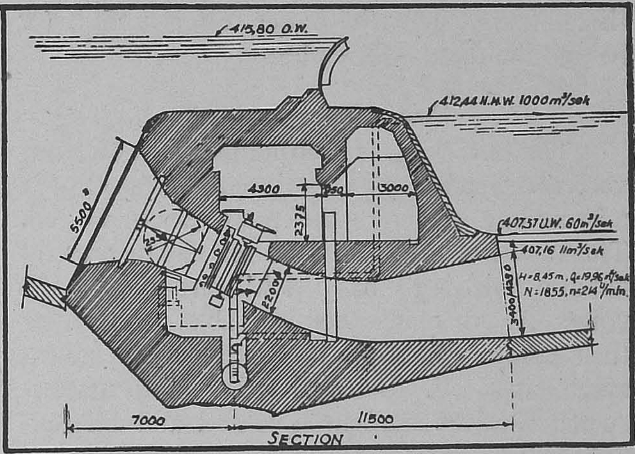
In the future, however, the whole electric plant will be fully automatic. Water-level meters will then be connected with sensitive devices, which will start and stop all machine sets automatically. At the same time, a long-distance operating line will be built, through which power output and water storage will be regulated according to the needs and conditions.

Saalach Power Plant

The Saalach Power Plant, one example of this design, is located near Salzburg, in Salzburg province. It was planned in 1939, when the constrution of a dam, necessary to protect the foundation of a nearby rail-road bridge from being washed out, was under consideration. Planned for 25 million kw annually, the plant has to supply about one-third of Salzburg's needs. The Saalach is a mountain river with a considerable amount of boulders present in the water. It forms the present Austro-German border. At the time the construction was begun, however, Austria was a part of Germany, and international agreements concerning the water's use were not necessary.

In 1941, the construction began, and immediately the first difficulties arose. The riverbed consists of a 25 foot-thick layer of quicksand with clay below. Long steel piles and heavy concrete anchors had to be placed, to secure a flow of 35,310 cubic feet per second at 60 feet water height. (See photo of section of dam.)





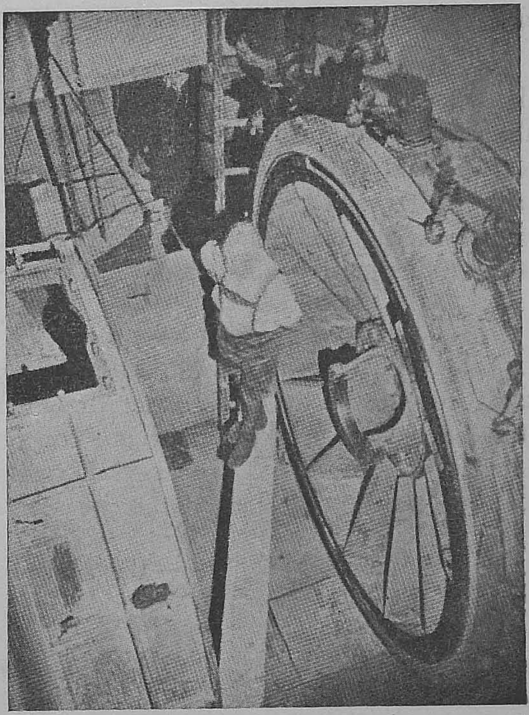
(Left) General plan of submersible plant.

(Right) Details of Saalach plant shown in this cross-section. 22 million kwh. annual capacity.

Shortage of raw material and skilled workers slowed the finish of the power plant, but by 1947 there was completed a 198-foot-wide dam having 3 work tubes and 4 blind tubes, the machinery housing on top of the tubes.

The work tubes were equipped with two propeller turbines with set blades, generating out 1,900 H. P. each. Installed in the slightly warped tube at a 26½° angle, the machine unit is fixed in the tube with four streamlined piles. The turbine is driven at a normal 214 rpm by 709.2 cfs. flow. The centre work tube was temporarily equipped with a Kaplan turbine having 12 fixset blades. The centre tube is scheduled to receive a Kaplan turbine with changeable blades for the full cfs. The presently-used turbine allows only 529.6 cfs. of the 709.2 cfs. flow.

The future centre turbine will be the most modern. On a steel axle at a 26½° angle, the 8-foot (diameter) turbine will rotate at 240 rpm; the blades, constructed to allow changes in the setting during operation, will be connected at their ends, forming an 8 ft. (diam.) circle or stationary steel band. The lower part of this band (toward the turbine's axle) will be in the water, while the upper part (or outside) is sealed from the water, and bears the armature, while the generator's coil is in the stationary circular band outside the tube, from which the electricity is collected.



Size of turbine indicated by man's height (Lechlower Plant)

The sealing, the most important detail in this construction, is made by specially-shaped rubber, which is directed by the flowing water toward the tube's wall. The small amount of

water which is pressed through the seal, is sucked into the chamber below the tube, and from there forced into the lower-water section (or behind the dam). (See photo.)

Power Transmission

The electricity is transmitted from the converter (A.C. and D.C. motors and flywheel) over a recording meter to the main electrical rail. The power of one 1,750 kVA unit can be directly led into Salzburg's basic 3 kV circuit, at 3,150 volts. All machine sets are able to transfer their combined out-put into the second Salzburg system at 25 kV. Safety devices include master-switches, compressed-air operated, and differential security devices.

Last year the Saalach waterworks derived from the small and quiet-flowing Saalach river 22 million kWh; the power plant has machinery for 5.5 MVA installed. Even if the production of electricity may be described as small, the output is equal to and steadier than that of other conventional types.

Experiences and conclusions are not yet available from this plant. But since the similar German ones have been producing electricity since the war started, a few words in general may be said by Germany's most experienced under-water plant engineer, Helmuth Fenzlaff, the initiator of this submersible plant.

Fenzlaff's Basic Idea

In all countries of the world, states designer Fenzlaff, progress in installing waterworks tends toward the goal of the plant's serving for more than merely the production of energy. Economy, agriculture, security against floods by control of the water's draft, as well as increasing the water's own ability to rid itself of boulders and dirt, are not unimportant considerations, especially in Europe, where the people live under much more crowded conditions than in other civilized countries. In 1931 Fenzlaff stated that the main characteristics of the "overflooded" water-works are to be found in these five points:

(1) Locating the plant within the river-bed, reaching from one dam to the other, at a 90-degree angle to the water draft.

(2) Use of the flowing water in a multi-unit installation of turbine and generator.

(3) Organic relation of blind tubes to work tubes.

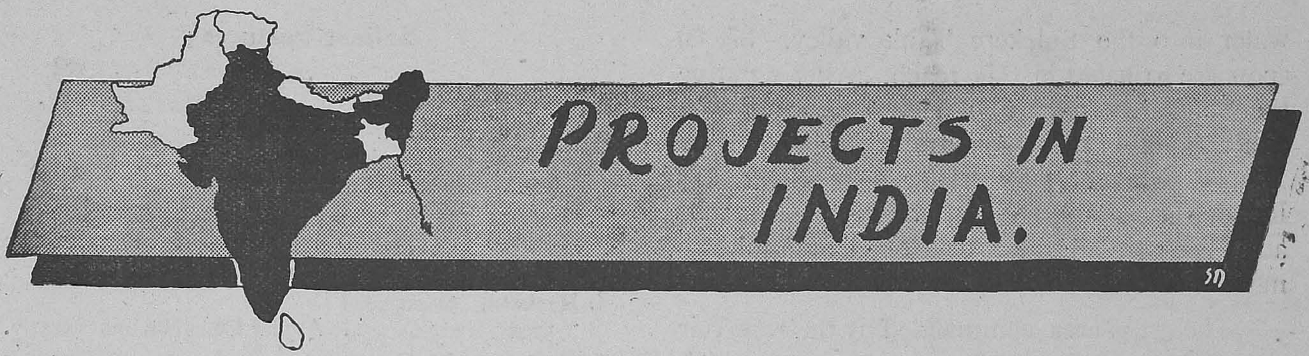
(4) Complete or at least partial overflooding of the whole installation.

(5) Turbine and blind tubes only slightly deviated from the natural draft direction.

These five characteristics are to-day, after almost twenty years, still valid in form, and the designers of underwater plants proceed on this theory.

Generally it might be stated, comparing construction and upkeep costs for under-water and above water plants, that not much difference can be found. But the question where to build either form of power plant must be decided entirely upon a basis of condition of the water. Underwater works are mainly for slow-moving water, with a steady rate of flow. This construction has the advantage that the landscape is not much disturbed. As a matter of fact, such a power plant adds the distinction of combining beauty of installation with economic profit to the localities where such works are established.

—With acknowledgments to "World Construction", July—August, 1951.



Bhadra Reservoir in Mysore

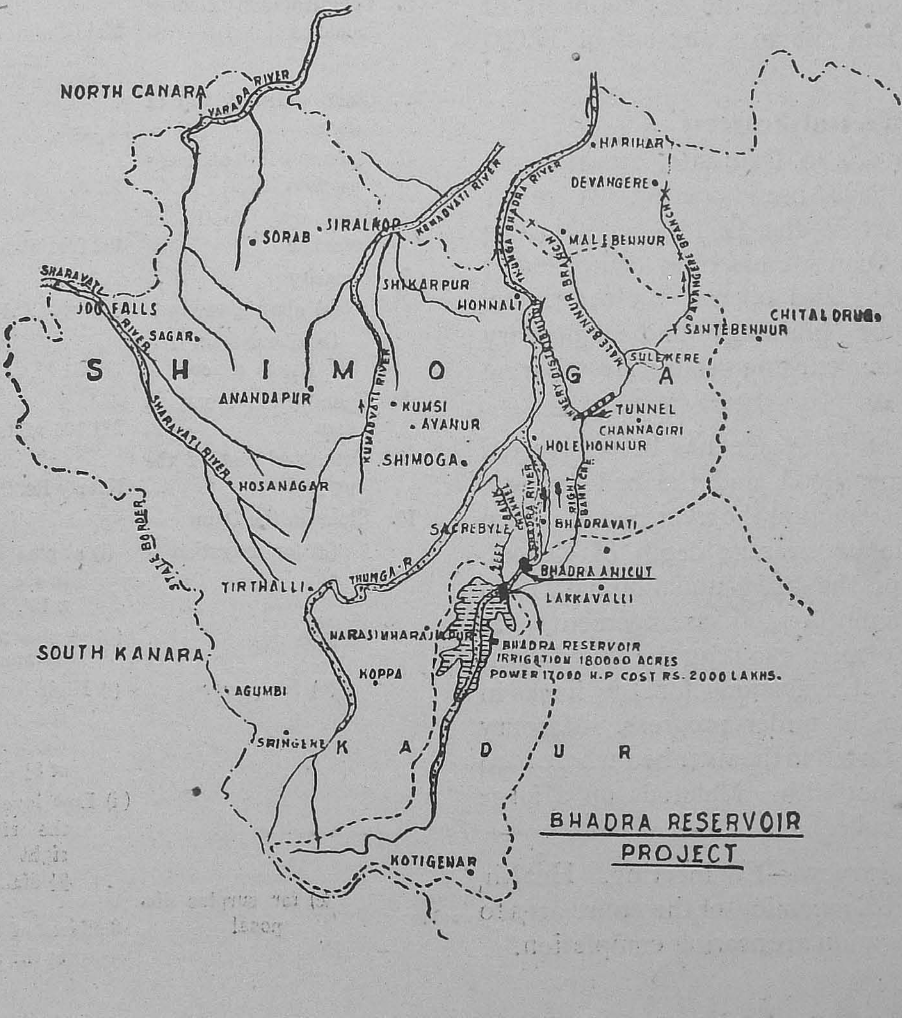
The construction of a Reservoir across the Bhadra at Lakkavalli forms one of the major irrigation schemes in the Tungabhadra Basin in the north-western part of the State.

The proposals envisage :—

(i) the construction of a reservoir to store 182 ft. depth of water to irrigate 180,000 acres of land in the arid tracts of Shimoga and Chitaldrug Districts;

(ii) the development of power of 17,000 H.P. (continuous) at Dam site.

Two main canals are proposed, one on either bank. The left bank channel, 30 miles long, irrigates 21,000 acres in Shimoga District. The right bank channel is 62 miles long and comprises 2 sections, the first section being 51½ miles up to the site of the tunnel (3 miles long) to be bored through a range of hills, dropping the



water into the Sulekere Tank valley. 37,000 acres are irrigated in this reach. After entering the Sulekere Tank, two high level canals on either bank of the tank are taken to irrigate 113,000 acres of very fertile lands in the dry District of Chitaldrug. A further extent of 9,000 acres is proposed to be developed by improvement of duty.

The gross area commanded by the reservoir channels is nearly 400,000 acres, out of which about 300,000 acres is the cultivable command. The area selected for irrigation is only 180,000 acres; the system of triennial rotation of cultivation of crops, viz., paddy, sugarcane and irrigated dry, is proposed to be adopted. The total cost of the scheme with the present day cost is worked out at Rs. 20 crores.

The scheme is of greatest utility to the dry taluks of Shimoga, Honnali, Channagiri, Davangere and Harihar in the Shimoga and Chitaldrug Districts, where the average annual rainfall is as low as 10" and varies between 10" to 25". The scheme also contemplates the development of power at the Dam site to an extent of 17,000 H.P.

Present Progress

Approach roads to Dam site, quarries and nearby places have been opened. A major R.C.C. bridge across the Bhadra one furlong lower down the Dam site has been completed at a cost of 3½ lakhs and opened out for traffic. Permanent office buildings and temporary quarters for the existing staff are nearing completion.

The river at Dam site has been diverted fully for summer flood and the bed exposed. Foundation excavation at the river bed has been carried down to an average depth of 40 feet. Core samples of the bed foundation have been taken and examined, and arrangements are being made for cement grouting the foundations under pressure. Excavations for the flanks in the river portion is under progress. Masonry work has been started in the river bed where hard rock has been met with. Materials on a large scale are under collection.

Intensive surveys—Engineering, Health, Agricultural and Economic—of the entire area to come under irrigation are nearing completion.

Salient Features

I. Hydrology

1. Catchment area ...	760 Sq. miles.
2. Width of river at dam site ...	300 feet.
3. Maximum flood discharge ...	94,500 cusecs. Provided for 120,000 cusecs.
4. Maximum waterspread area ...	At plus 182—47 Sq. miles nearly.
5. Maximum length at maximum waterspread.	10½ miles.
6. Rainfall ...	
(a) In catchment area ...	202" at Kotigehar to 46" at Lakkavalli.
(b) In atchkat area.	36" at Tarikere to 20" at Malebennur.

II. Construction Details

1. Situation ...	Across the river Bhadra near Lakkavalli, Tarikere Tq., Chickmagalpur Dt.
2. Greatest height of dam above foundation ...	230 feet.
3. Length of dam including saddles ...	Main Dam. in river portion 1320 Ft. 1st saddle 1340 Ft. 2nd Saddle 700 ft.
4. Road width at top of dam ...	15 feet.
5. Bottom width at deepest foundation ...	229 ft.
6. Maximum depth of storage ...	182 feet above river bed.
7. Capacity ...	
(a) above river bed.	67,588 M.C.Ft. at plus 180.
(b) above main Irrigation sluice ...	58,884 M.C. Ft. at plus 180.
8. Quantity of masonry in dam ...	221,106 units of 100 cft.
9. Estimated cost of the project ...	Nearly Rs. 20 crores.
10. Sluice in the Dam ...	
(a) for irrigation ...	(i) at plus 100 in river portion in the right bank—2 of 6' x 15'.
	(ii) at plus 35 for the left bank channel—2 of 6' dia.
(b) for power ...	(i) High level turbine sluice in the river portion in the right bank at plus 120—3 of 8½ dia.
	(i) Low level turbine sluice of the river portion in the right bank at plus 50—3 of 8½ dia.
(c) for surplus disposal ...	8 sluices of 10' x 25' proposed in in the river portion.

II. Submersion :

(i) No. of villages that get submerged ...	25
(ii) Wet and garden lands submerged ...	5252 acres.
(iii) Dry lands submerged ...	1690 acres.
(iv) State forest submerged ...	6585 acres plus 901 acres of teak forest.
(v) Other area submerged ...	11,675 acres.
(vi) Miscellaneous properties that get submerged ...	Tarikere-Mangalore road 17 miles. Bhadravati—Narasimharajapur road 8 miles. Tarikere — Narasimbrajapur tramway 12 miles. M.I.S.W. Tramway—15 miles.

III. Hydro Electric :—

Proposed power development ...	17,000 H.P. continuous or 21,500 H.P. peak load with 80% load factor

IV. Irrigation—(Proposed as per sanction)

1. Irrigation in left bank.	Under left bank channel, length 30 miles. Irrigation—21,000 acres. Maximum capacity—335 cusecs (20′ bed width. 6′ full supply depth.)
2. Irrigation in right bank.	Maximum capacity at start 2,500 cus. Direct irrigation up to tunnel length, 55 miles—22,000 acres. Anvery distributary—length 36 miles. Irrigation—15,000 acres. Davangere Branch 37½ miles. Irrigation 71,000 acres. Malebennur Branch—length 25 miles. Irrigation—42,000 acres. Extra by improvement of duty 9,000 acres.
3. Details of tunnel channel ...	For right bank canal from its 55th mile to 62nd mile. Capacity of tunnel—1926 cusecs.
4. Irrigable area commanded ...	300,000 acres.

—With acknowledgments to the "Indian Journal of Power & River Valley Development," January 1952.

Reconstruction of the Krishna Anicut: 1952-53.

On 24-5-'52 there was a sudden rise in the water level in the Krishna river. There was no warning of the approaching flood from Kurnool. The shutters over the anicut were in an erect position and had been clamped, to facilitate repairs to the shutters which were going on at the time. The water level which was -0.60 at 12 Noon rose from 3 p.m. very rapidly and reached the maximum of 15 feet over the crest by the next morning.

As the shutters were standing and locking pins had not been removed, the tripping of the shutters, through hydraulic pressure could not be done. The steam plough could not also be commissioned into operation as it would take more than two hours to get up steam at the required pressure. As every one was caught unawares, nothing could be done except to open the under sluices on the Vijayawada side to build up the rear water level. The under sluices on the Sithanagaram side could not be operated with water level above 6 ft. over crest.

The flood level subsided slowly after 26-5-52. With water level 15 ft. over the crest, the water shot out clear over the top of shutters and a mass of water 9 ft. in depth, with a drop varying from 9' to 15', hurled itself on the first apron. This process continued with varying intensity, until sufficient water had accumulated to the rear of the anicut, to serve as some sort of water cushion. Added to this impact, considerable uplift pressure must have also developed in this section of the anicut as there are no openings for relief pressure in the two grouted aprons. This must have had serious consequence on account of an effective head of 13 ft. over the anicut. The result was that numerous scours, some as deep as 14 ft. were formed in the first apron. These were repaired by filling in with stone and grouting the top surface with cement concrete to the extent possible within the limited time available before floods. The maximum flood level recorded was 12.3 over the crest in July and August 1952.

The incidence of floods in July and August which reached a level of 12.3 over the crest against 15 ft. in May was sufficient enough to disrupt the emergency repair works already carried out. In the first week of September new scours were noticed adjacent to the patched up scour below the fourth set of shutters in the first apron. This scour steadily extended its margins taking in with it the old scour and finally reached the bodywall causing a breach of about 130 ft. length before effective preventive measures could be taken up. The resulting scour reached depths of over twenty feet.

The emergent work of closing the breach was put on hand immediately in order to save the standing crops in the delta and also to localise the breach. Considerable difficulty was encountered in this work of forming a ring-bund at the up stream of the breach, as any approach within a distance of about 100 ft. was not possible due to high velocity and deep currents.

On the evening of 9th September 1952 at 5-30 p. m. while attempting to sink punts to form the ring bund (the actual procedure adopted is not known), the ropes holding the punt in position, snapped themselves from the moorings and drifted with the current towards the breach resulting in the loss of the precious lives of officers and men.

The breach closing work was continued and completed successfully on 24-9-52, the interspaces in the ring bund being filled with stones. The bund was covered over with sand bags and was raised to a height of 9' above the crest of the anicut so as to provide for sufficient margin above low floods and also to force water for irrigation. Notwithstanding the tragic background under which the work was completed, it was possible for the Engineers to ensure adequate supplies to the delta ayacut and to see that not an acre of field suffered for want of irrigation supply.

Further works under instruction of the Chief Engineer Irrigation have since been taken up to close the breach and restore the anicut to its standards.

These are detailed below :—

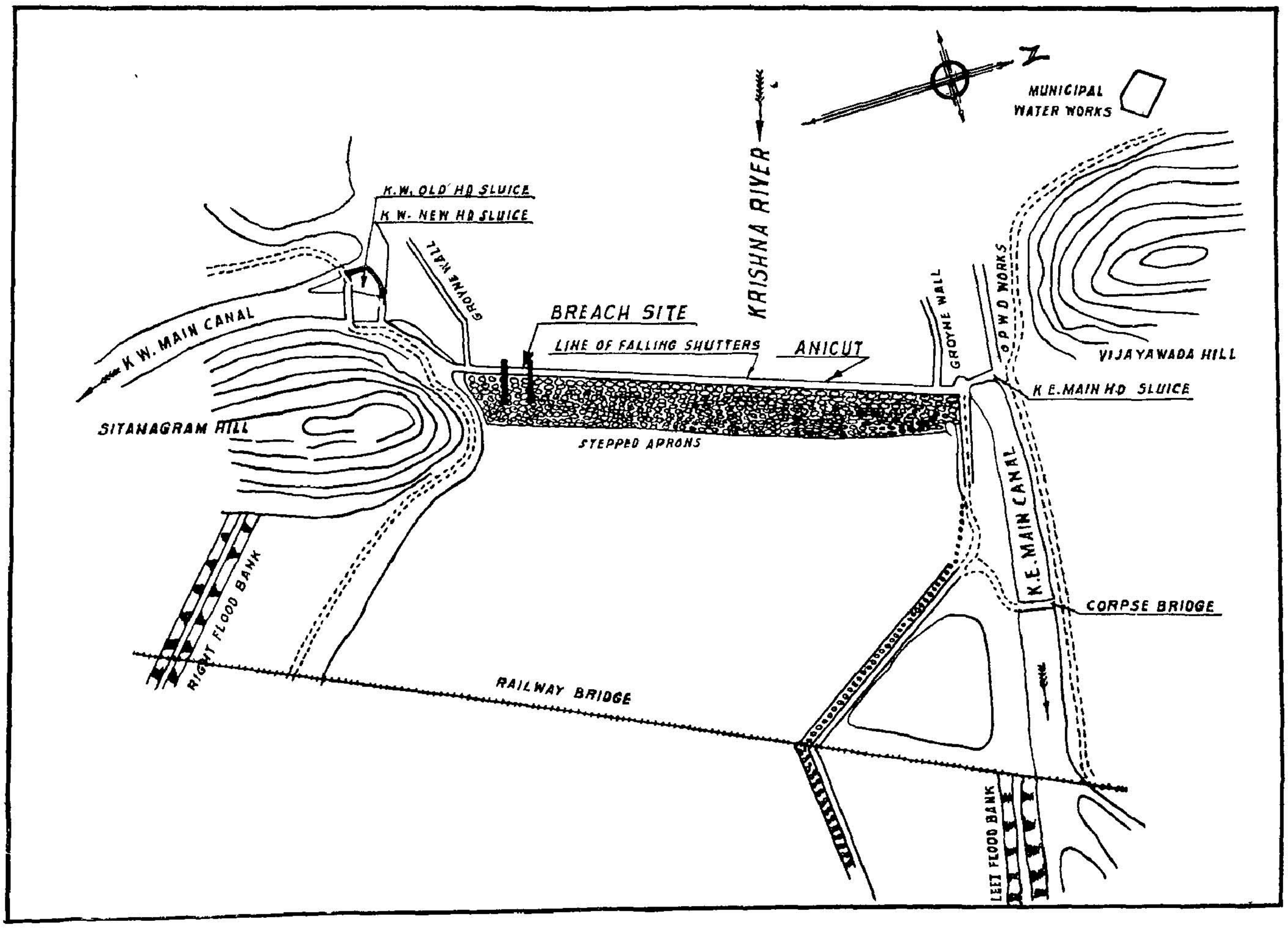
I-1. A coffer dam with clay, in a ring bund all round the breach on the upstream side, in order to lower the water level in the breached portion of bodywall of the anicut and to facilitate reconstruction work. In addition to the formation of the clay bund, a clay blanket was formed on the river bed for a width of 40′ upstream of the ring bund, so as to reduce or seal off seepage of water.

I-2. The work of reconstructing the body-wall and aprons at breach site consists of exavation and removal of all dumped stones, as well as all the punts sunk during the breach closing operations and reconstructing the body-wall and aprons with cement concrete, thickness of aprons varying from 3 ft. to 6 ft. Steel sheet piles were driven on either side of the foundations of body-wall. To serve as a cut off wall, on the upstream side of the breach, piles obtained from Tata Iron Co., are also being driven, from about 175 ft. above the anicut.

I-3. *Repairs to Scours in firstApron*: The work consists of dismantling the damaged aprons, removing all the stones to the required levels and reconstructing the aprons as stepped aprons in cement concrete. Repairs are proposed only for the damaged portions of the aprons and to all appearance the rest of the aprons are in tact though there might be undetected hollows here and there.

I-4. *Repairs to second and third Aprons*: Wherever the 2nd and 3rd aprons were damaged they are being refilled with stone and the top finished off with cement concrete blocks (2 ft. cubes) fixed in concrete.

I-5. *Repairs to fourth Apron and Talus*: The fourth apron which was damaged in portions has been rebuilt after filling hollows with required stone and finishing the top with 2 ft. cement con-



crete cubes. The talus has been restored by dumping rough stone and pitching jeddy stones on top. Further, for the deep course of the river, between the anicut and the railway bridge, a rough stone groyne is being formed to arrest further deepening of the river course.

II. *Repairs to and renewal of six feet falling shutters*: Renewal of the anicut shutters, which were washed away in the breached portion of the anicut and also for replacement of other damaged shutters as well as repairs to all the shutters are under progress. Hydraulic pipes which are used in tripping the falling shutters were damaged with the result that the anicut shutters were not responding to hydraulic pressure. The old hydraulic pipes which were fixed in concrete have been excavated and good ones substituted in their stead. On one half of the anicut (on the Seethanagaram side) old hydraulic pipes (in good condition), salvaged from the other half have been used. For the other half of the anicut on the Vijayawada side, new pipes have been installed in a trench provided for the purpose. This trench has removable chequered plate covering so as to facilitate periodical inspection and maintenanee. Provision for purchasing the hydraulic pipes from the United Kingdom have also been made.

III. *Replacing the Steam Boiler, by Diesel Motor on the Plough*: One of the two ploughs has been converted from steam drive to Diesel drive, so that it will be available for use, at short notice during an emergency.

IV. *Machinery Equipment*: All kinds of machinery necessary for the execution of the work, such as pumps, air compressors, paving breakers, jack hammers, diving sets, cranes, concrete mixers and vibrators, tram lines and trucks lorries, welding plant, pile driving frame, pile driving hammers, oxy-acetylene cutting apparatus etc., have all been procured. Most of the machinery has been diverted from other divisions and projects.

V. *Construction of Store Sheds and Rest Sheds etc*: These works are proposed for storing materials and for giving facilities for imported labour etc.

VI. Lighting arrangements for night work, laying tram lines for transport of materials, and other important conveniences for the speedy execution of the work have all been undertaken.

The photos in the supplement give a general idea of the works enumerated above.

This report is of a preliminary nature. A comprehensive account of the Restoration of the anicut is expected to be published in the "Era" in due course.

Reconstruction of the Krishna Anicut at the Breach Site
(Art Supplement)

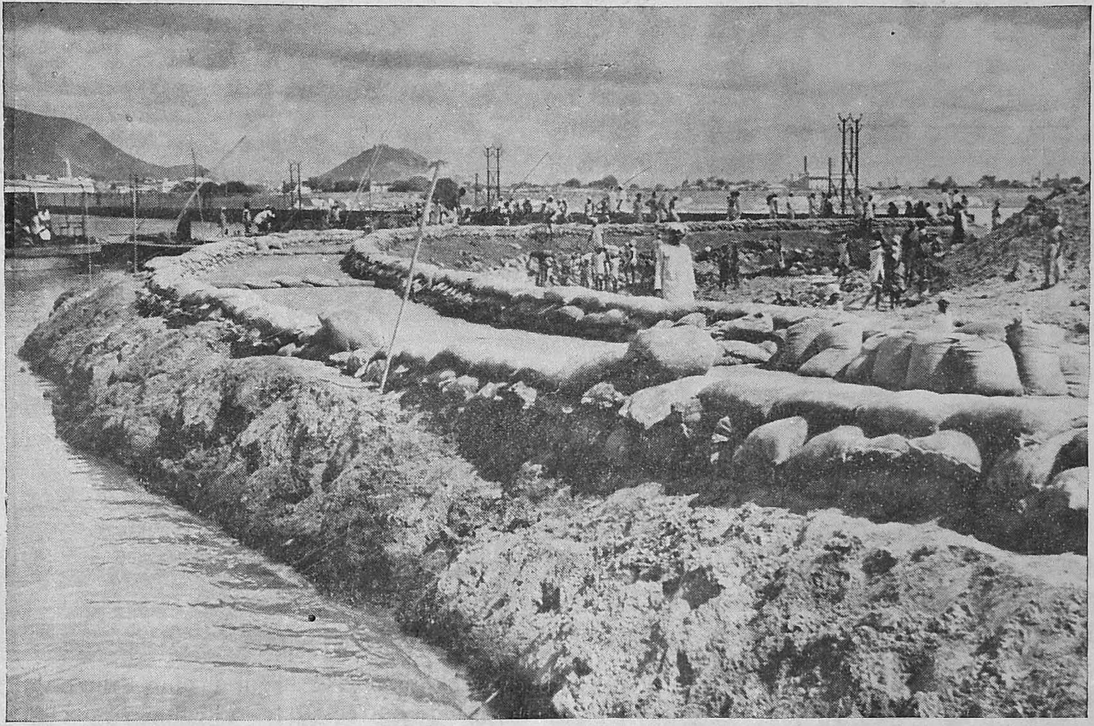


Fig. 1. A close up of the ring bund at breach site. (11-12-52)

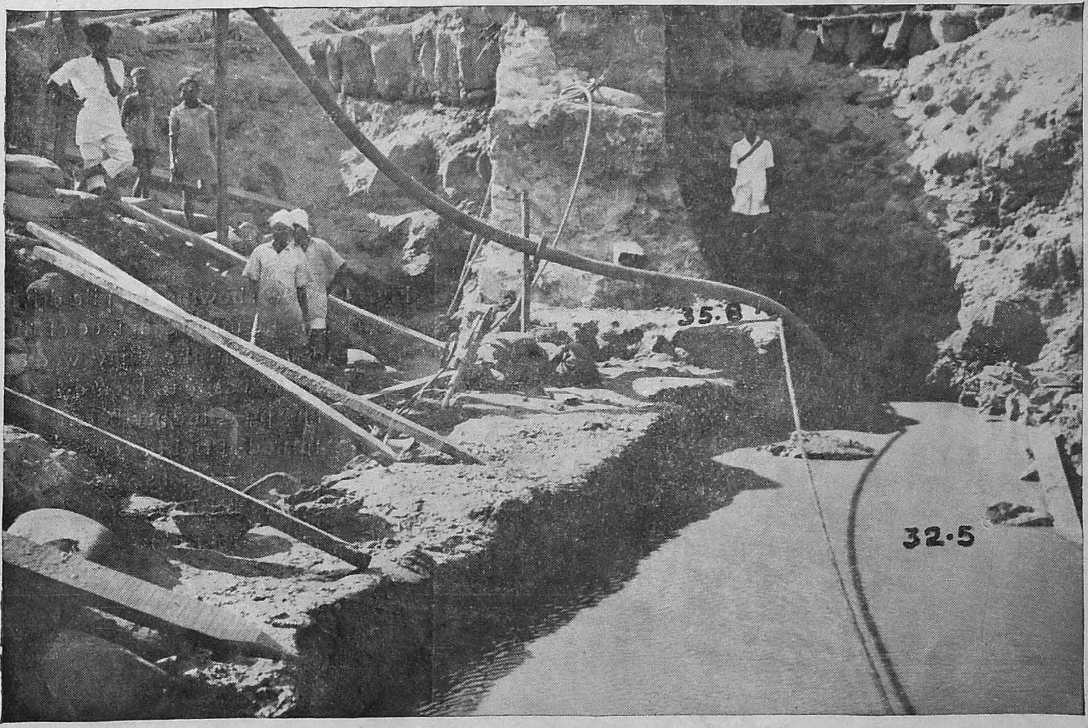


Fig. 2. View of the Sithanagaram end of the breach showing the section along which the body-wall was severed. The rope line in the picture shows the line of up-stream face of the capping slab. The breached portion of the body-wall is seen lying with a radial movement. The foundation trench at the site is 20' wide. The water level in the trench is at + 32.5. (23-12-52)

Fig. 3. View showing the downstream face of the body-wall on the Sithanagaram end of the breach. The plumb line with stone at bottom is the north end of shutter 3/11. The top of well is at + 31.8. The wells are of brick masonry 5 ft. external diameter at 7 ft. centres (27-12-52)

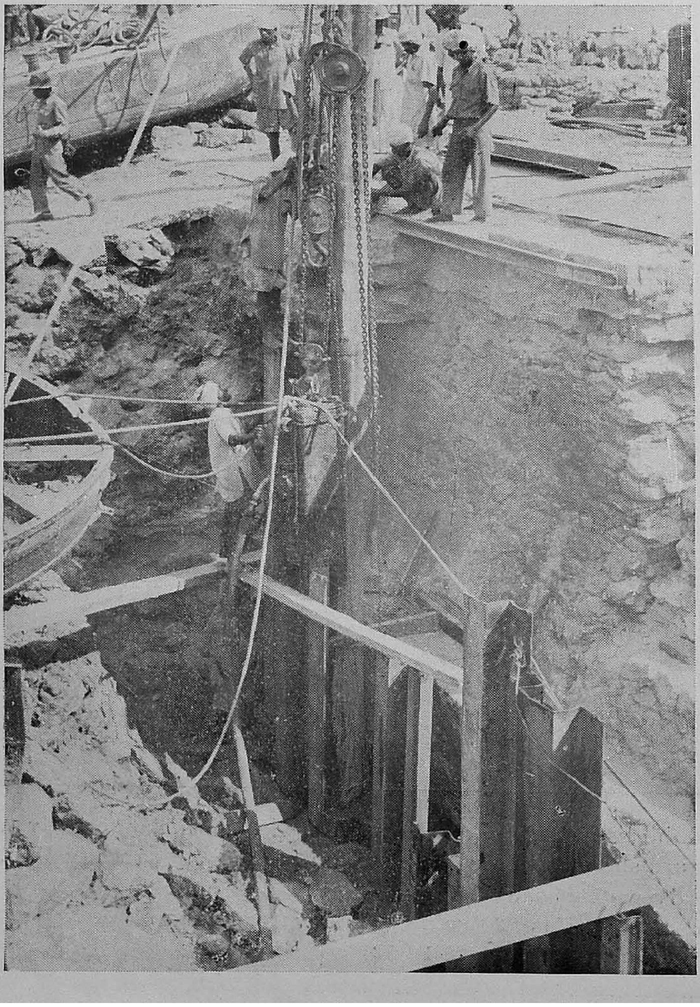


Fig. 4. View showing the pile driving work on the up-stream face of the foundations at the Vijayawada end, (opposite to Figure 2). The pipe line has been turned at right angles to butt against the old brick wells. (15-1-53)

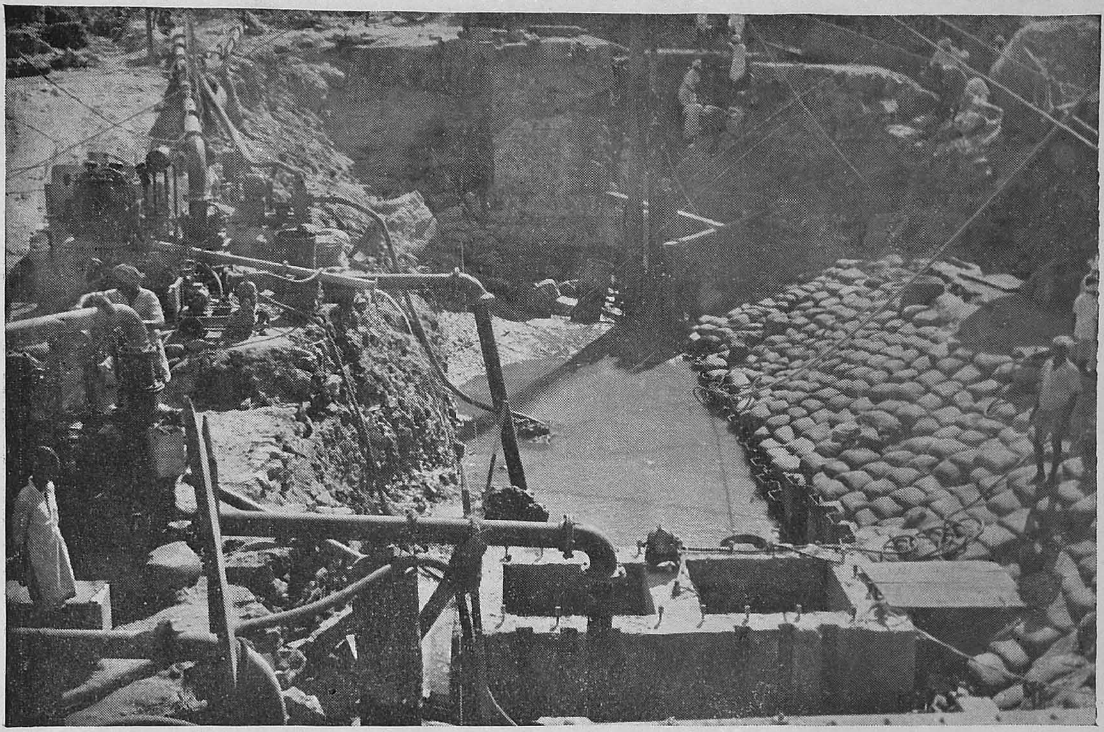


Fig 5. View showing the up-stream side line of piles driven in the foundation trench at breach site. The water level in the trench is at + 20.2 The top of the piles is at + 29.8. The R. C. twin well has been sunk to + 24.0 (15-1-53)

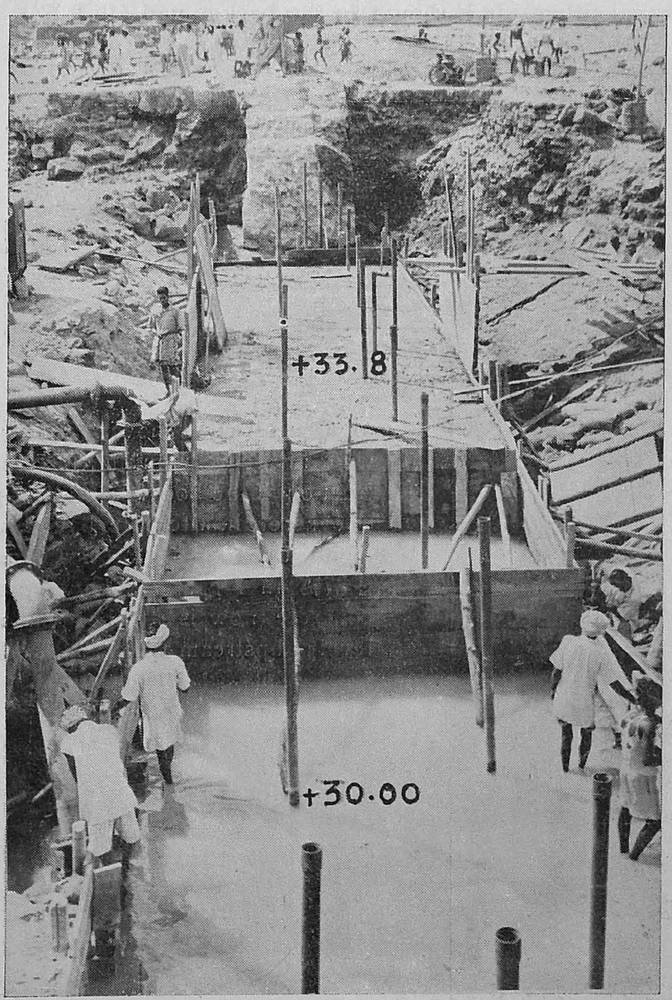


Fig. 6. View showing the concreting work in progress for the bod-ywall at breach site. Shuttering that is being done, for dividing the area into compartments, is also seen. The water level in the trench is at + 30.0 and it is just above the concrete layer. Further work on concreting is also seen in the middle portion of trench. The top of concrete laid is + 33.8. Grout pipes kept in position are also seen. The body-wall which got displaced from the Sithanagaram Flank of the breach (Figure 2) is now getting ready for proper alignment with steps for bonding the old and new works.

(8.2-53)

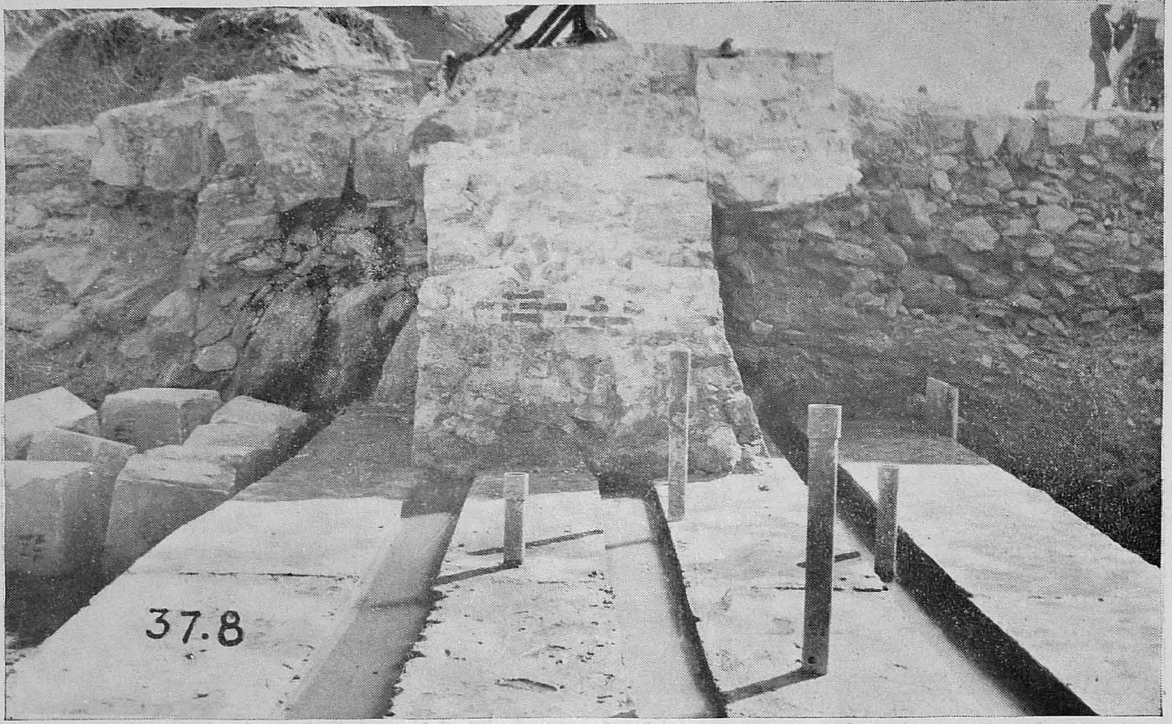


Fig. 7. View showing the re-construction work in progress at Sithanagaram end. The new body-wall has been built upto + 37.8. The grout pipes fixed in the construction at regular intervals are also seen. Longitudinal grooves are left at top for keying with further work. The old body-wall with its aprons on either side is shown in the background (15-2-53)

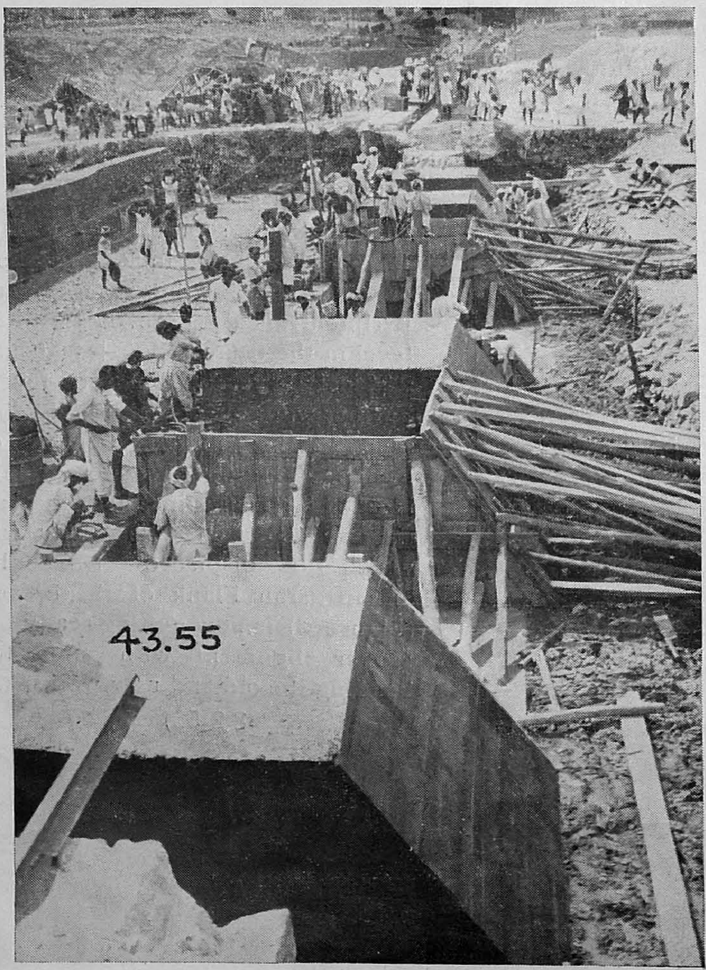


Fig. 8. General view showing further work in progress on the reconstruction of the bodywall. The top of concrete in alternate bays has come up to +43.55. against +37.8 in Figure-7. The top of concrete now is at the bottom level of upstream apron. (22-2-53)

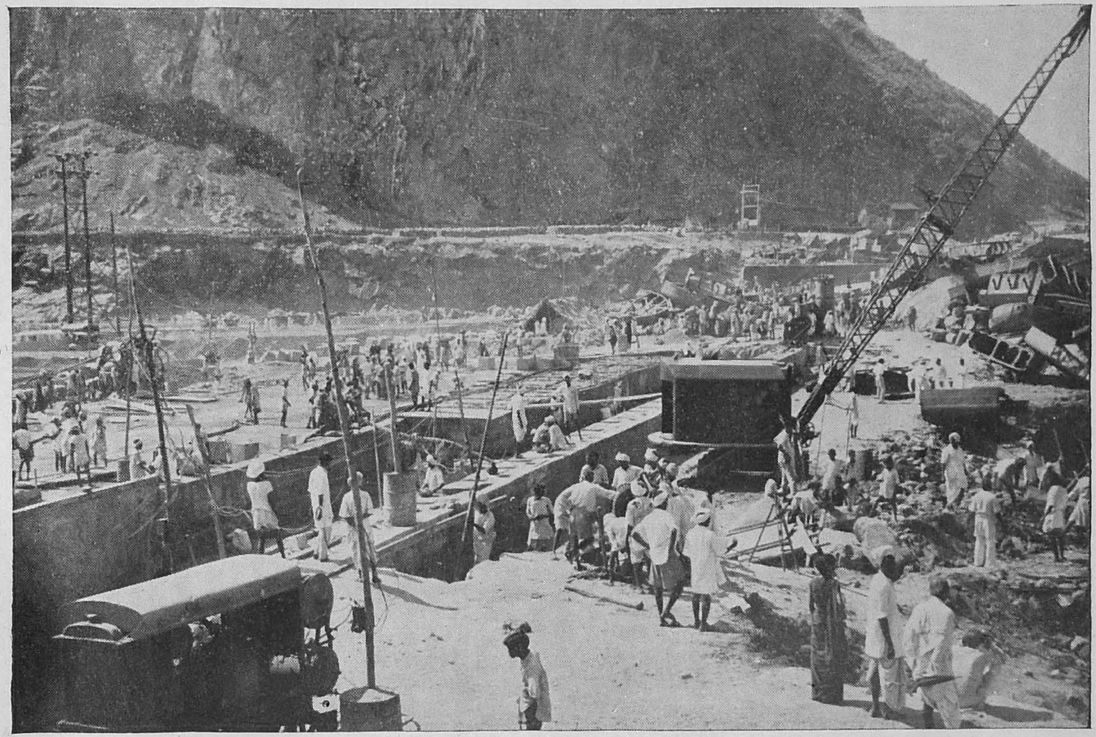


Fig 9. Picture showing the body-wall that has been constructed for breach portion. The 19RB is clearing punts on upstream side. Reconstruction of down-stream apron is also in progress. (8-3-53)

Fig. 10. Repairs to 1st apron-Reach VI-View at Sithanagaram end. Dismantling has been done upto body-wall. Concreting of 1st apron is in progress. The shutters and the plough rail in rear of them can also be seen in the picture. (4-2-53)

B A—Bodywall (Rear face.)

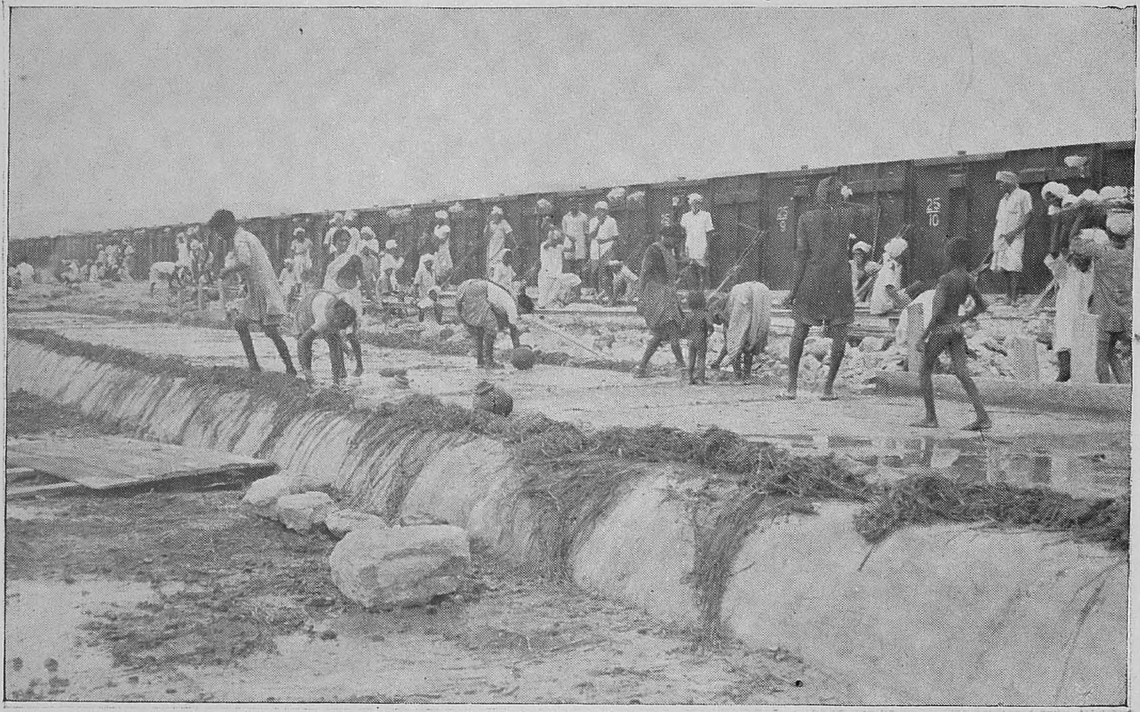


Fig. 11. Photo showing the progress of work in the third reach on 23-2-53. The finished portions of the first and second steps of the first apron formed with mass concrete are seen in the photo. Dismantling of old apron near the plough track is also seen in the photo. (23-2-53)

Fig. 12. Pitching of cement concrete blocks 2 ft. cubes, in progress. (23-2-53)

Fig. 13. *Formation of Groyne* : Picture showing the alignment of punts with tramway lines for the formation of groyne in deep scour. Arrangement has been made for dumping of rough stone into it. (1-3-53)

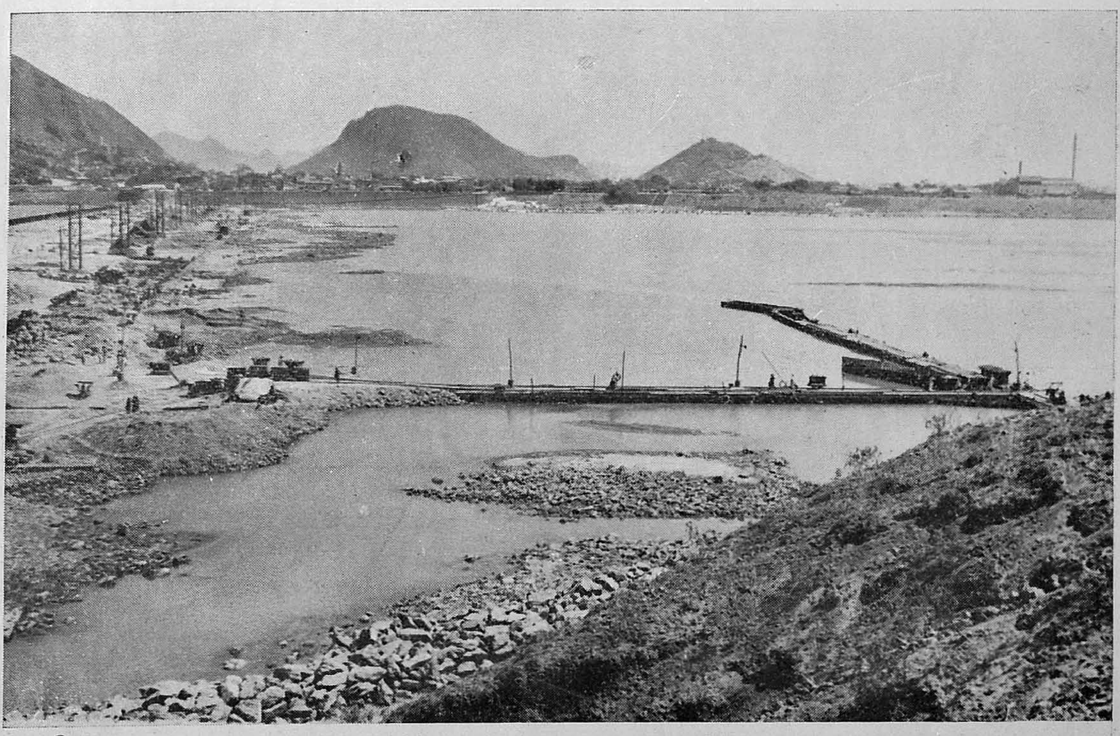


Fig. 14. Picture showing the river downstream of the anicut. The cross-bund formed opposite the breach site is in a line with the punts still in position. (22-3-53)

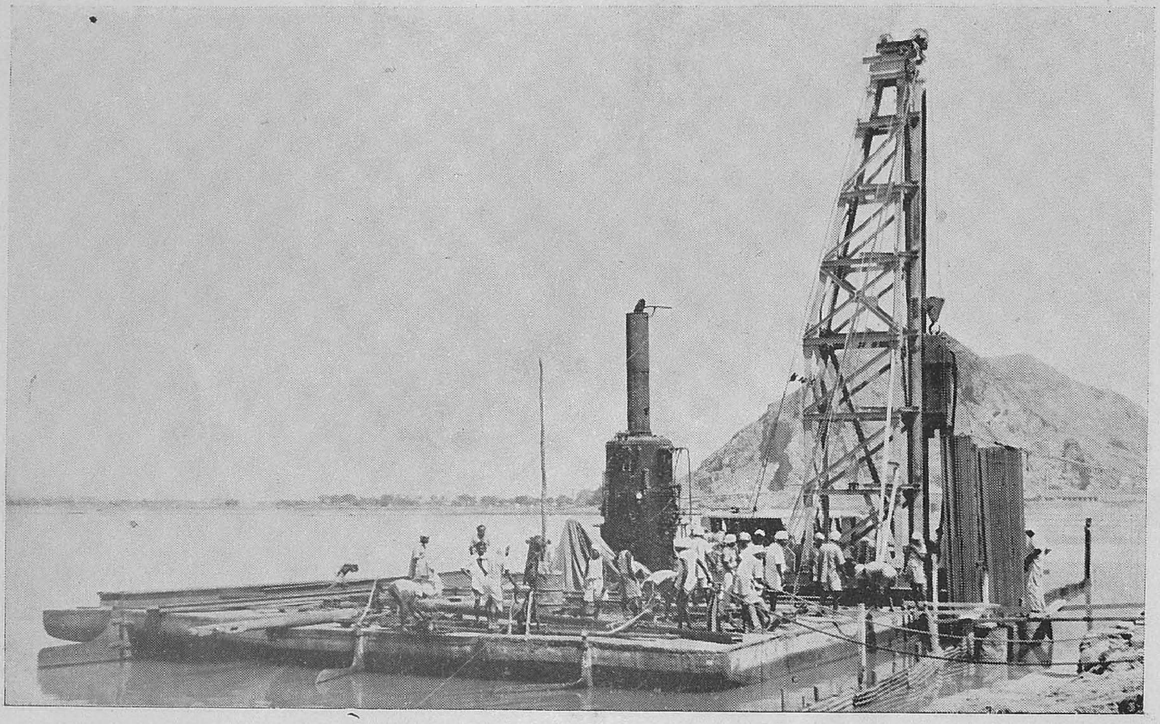


Fig. 15. General view showing the pile driving equipment mounted on barge. The air compressor working the pile driving hammer is on the background on the barge. (4.3.53)

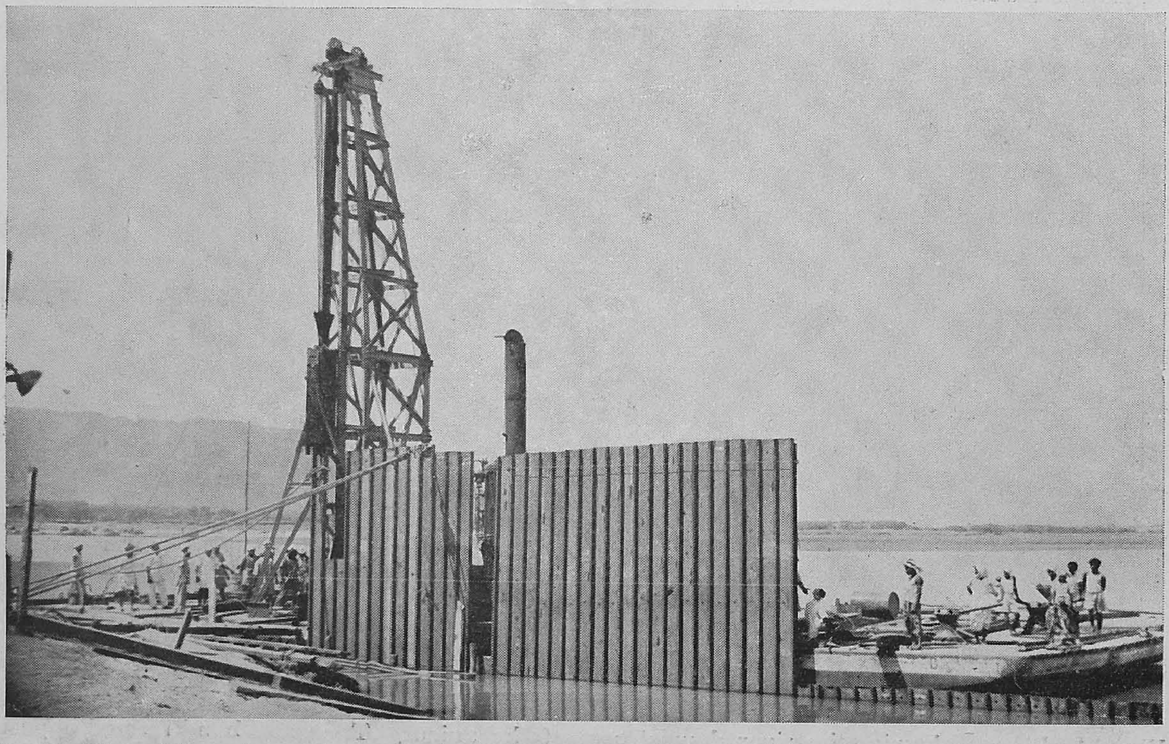


Fig. 16. The picture shows the method of driving piles. The finished piles are seen on the left. The picture shows in detail the pitching method of pile driving. (4-3-53)

The Palar River.

The river Palar has its source near Chintamani near Kolar District of the Mysore State. It has a length of nearly 50 miles in Mysore State and drains an area of about 1088 sq. miles upto the Madras border. Just above this border, there is a big tank by name Ramasagar and upstream of this there is another one by name Bethamangala. This latter is the main source of water supply for the Kolar Gold Fields and Kolar Municipality. The river enters the Norh Arcot district of the Madras State and 30 miles further down it falls through the gorges of the Eastern ghats into the Vaniambadi valley. Thereafter it enters the Chingleput district and finally empties itself into the Bay of Bengal some miles south of Sadras, the Old Dutch settlement. The total length of the river from its source to its exit is 220 miles and the total drainage is about 5,000 sq. miles. In the Madras State, many tributaries join the river and the drainage area in this state is about 4,000 sq. miles.

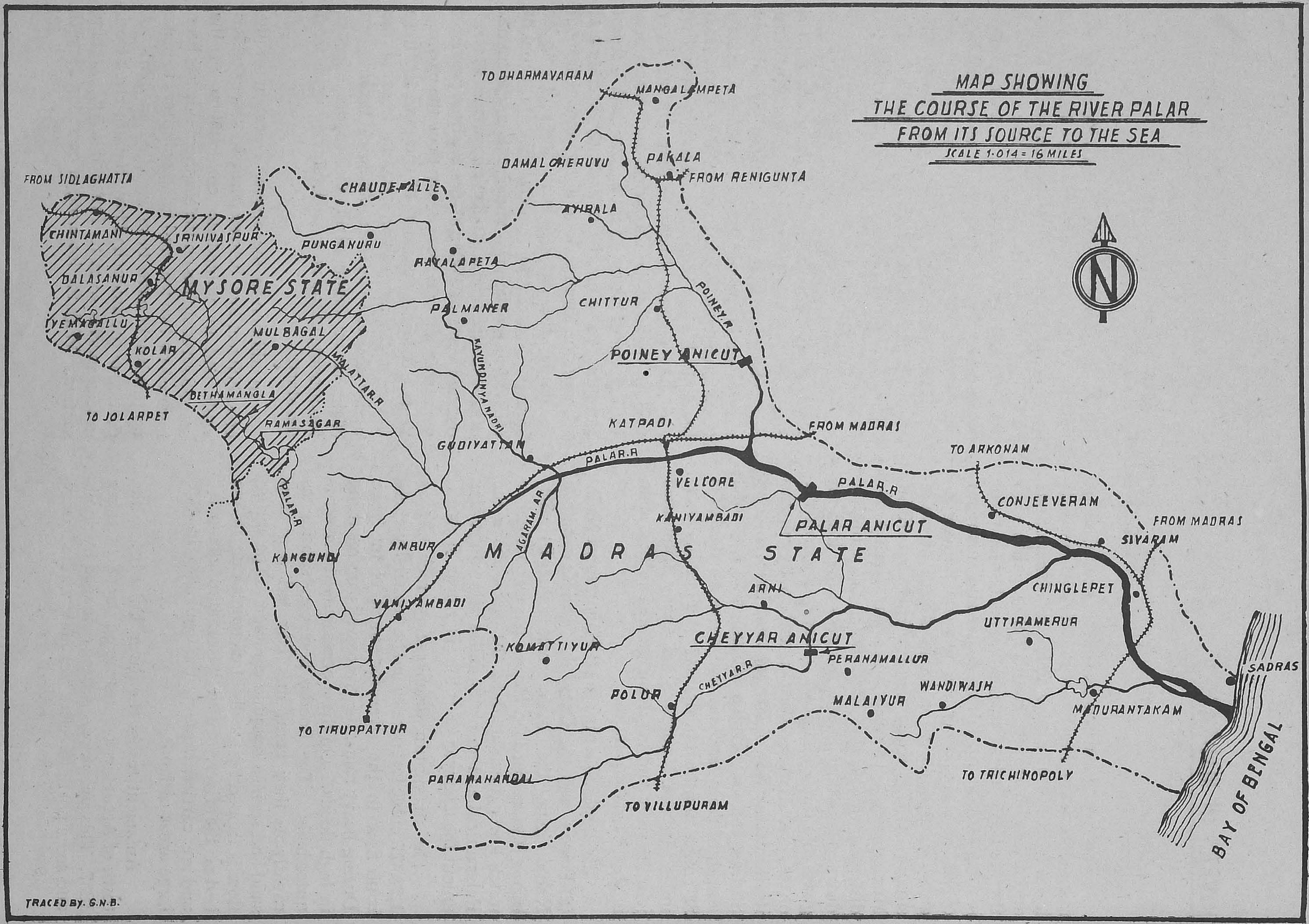
Its chief affluents are (1) Kavundinya Nadhi (2) Poiney and (3) Cheyyar. The Kavundinya Nadhi joins the main river some 70 miles below Mysore border; Poiney has its confluence much lower down at about 10 miles above the Palar anicut and nearly 35 miles below the Palar anicut the Cheyyar joins the river near Sivaram.

The maximum discharge is reckoned as 1,58,477 cubic feet per second but generally there is no flow in the river for most of the year. During heavy rains, the river swells up resulting in high floods. On these occassions the river is unfordable. The floods, however, subside as rapidly as they come in. The bed is of deep sand and springs are quite common. The spring flow is tapped by means of channels dug in the bed of the river, called "Korambu channels" and are carried through the banks to irrigate large areas of lands,

An anicut across the River Palar below the town of Arcot was constructed by September 1857. This anicut, was getting damaged by floods and some portions were actually washed away during the floods of 1903. In 1905 the anicut was finally brought to standards and its length since this restoration is 2628 feet. The anicut is founded on two rows of circular wells three feet inner diameter and eight feet deep. It is sunk 12½ feet below bed. The body wall is seven feet high with the top width varying from four to four and a half feet and a base width of eight feet. The crest of the anicut is at M.S.L. 496.38. The highest flood level recorded was 504.23 on 12-11-1903.

There are as many as 42 undervents 5′ x 4′ in this structure. Twenty of these are on the Southern side and the rest are on the Northern side. Out of the twenty-two vents at this end, only ten are functioning and the rest near the Northern flank have been blocked up in 1903. Considerable difficulty has been experienced in operating the Northern side sluices as they are far away from the head of the Kaveripak and Mahendravadi channels taking off from this flank. Apart from this, there has been a steady accretion of silt with the formation of a big and high shoal separating the channel head from the under sluices. In order to remedy this, nine out of the twelve blocked up undervents in the immediate vicinity of the north flank have been opened out and vents of 5′-0″ x 3′-6″ have been provided with their sill one foot higher than the existing vents. A leading channel 40′ wide and 300′ long has been cut across the shoal in front of the under sluices so as to enable quick flushing out of the accumulation of silt and ensure effective functioning of the new undersluices right from the start.

In addition to the above, a portion of the crest 300 feet long between the two sets of undervents and in immediate continuation of the second set of sluices on the Northern side has been lowered by two feet and falling shutters to make up this height have been installed in 1951. A portion of the anicut had been built of brick work in lean mortar so as to function as a breaching section. With the lowering of crest for a length


MAP SHOWING
THE COURSE OF THE RIVER PALAR
FROM ITS SOURCE TO THE SEA
SCALE 1·014 = 16 MILES
N
TO DHARMAVARAM
MANGALAMPETA
PAKALA
FROM RENIGUNTA
DAMAL CHERUVU
FROM SIDLAGHATTA
CHAUDEPALLE
AYIRALA
CHINTAMANI
SRINIVASPUR
PUNGANURU
RAYALAPETA
BALASANUR
MYSORE STATE
CHITTUR
POINEY.R
PALMANER
IYEMAGALLU
MULBAGAL
KOLAR
POINEY ANICUT
MALATTAR.R
KAVUNDINYA NADHI
BETHAMANGLA
TO JOLARPET
RAMASAGAR
KATPADI
FROM MADRAS
GUDIYATTAM
PALAR.R
TO ARKONAM
VELLORE
PALAR.R
CONJEEVERAM
KANIYAMBADI
PALAR ANICUT
FROM MADRAS
AGARAM.AR
SIVARAM
KANGUNDI
AMBUR
MADRAS STATE
ARNI
CHINGLEPET
VANIYAMBADI
UTTIRAMERUR
CHEYYAR ANICUT
KOMATTIYUR
PERANAMALLUR
SADRAS
CHEYYAR.R
WANDIWASH
POLUR
MALAIYUR
MADURANTAKAM
TO TIRUPPATTUR
BAY OF BENGAL
TO TRICHINOPOLY
PARAMANANDAL
TO VILLUPURAM
TRACED BY. G.N.B.

Channels in the Northern Flank.

(1) *The Mahendravadi Channel*: The Head Sluice consists of 3 vents 3′ x 3′ each. This channel derives its name from the tank into which it finally empties. It is 24 miles and 72 chains long. In its course it feeds about 28 tanks. The aggregate area served is 4,849 acres, and its carrying capacity is 552 cusecs.

(2) *The Kaveripakkam tank supply channel*: The head sluice consists of 18 vents of 5′ x 5′. The main channel is about 11 miles long and derives its name from the Kaveripakkam tank to supply which it is mainly intended. The maximum carrying capacity of the channel is 3,443 cusecs and total area served is 6,675 acres.

(3) At a place called Gananadi, and at about 3 miles below the head, the Govindavadi channel takes off from main Kaveripakkam channel. The Govindavadi channel feeds 8 tanks and finally empties itself into the Govindavadi tank.

(4) The Kombakkal channel takes off from the Right Bank of the Govindavadi channel opposite to Damal Village and after feeding many tanks finally empties into the Sriperumbudur tank.

(5) *Kaveripakkam tank surplus channel*: This is about 28 miles long with its head at the surplus weir of Kaveripakkam tank and is the main source for the Kortalaiyar, popularly associated with supply of water to the Madras city.

Channels in the Southern Flank.

(1) *Sakkramallur tank supply channel*: This starts from the Right Bank and is 20 miles 4 furlongs long. The Head Sluice is of 3 vents six feet by three feet each. It feeds Sakkaramallur and other tanks and finally falls into Vengalattur tank throwing branches for other tanks *en-route*. The surplus from the Vengalattur tank joins the Rajakkal and finds its way into the Dusi-Mamandur Tank. It has a branch called the Anaithangal branch which feeds ten tanks in the south. The maximum carrying capacity is 624 cusecs and the ayacut served is 5,105 acres.

(2) *The Thennampattu or Dusi Channel*: The Head sluice is of 15 vents of five feet by three feet each. This starts from a head on the south main channel and divides itself into two. Regulation is provided by means of needle shutters with sill one foot below the head sluice. The right side branch is called the (2.a) Kalavai tank channel and the left side (2.b) Dusi Channel. The former is about 14 miles long and the latter is 23 miles. The latter takes its name from the tank into which it falls. In its course it supplies 54 tanks. The Kalavai channel feeds about 17 tanks above Kalavai tank and 14 below it. The maximum carrying capacity of the channel is 1,598cusecs, and the total area served is 19,903 acres.

(3) *The Rajakkal Channel*: This is about 13 miles long and takes off near Seyyanur and falls into the Dusi Mamandur Tank.

Statistical Data:

Drainage area	...	3,974 Sq. Miles
Maximum flood discharge	...	1,58,477 c. ft. per sec.

Irrigation in acres:

Mahendravadi channel	...	4,849
Sakkaramallur channel	...	5,105
Kaveripakkam main channel and branches (6,675+40,017)		46,692
Dusi Channel	...	19,903
Total	...	76,549 or 76.5 thousands.

Anticipated Tonnage of rice	38,000 tons.
Estimated Value of crop produced	Rs. 76 Lakhs.

QUOTABLE QUOTES

So You Want to be a Superintendent?

If anybody believes it's easy to be a modern construction superintendent, or that this piece contains any easy short cuts, he can stop reading right now.

For there are no short cuts. Today's superintendent or project manager has one of the toughest jobs in America.

There are no substitutes for the things he needs. They're as definite as black and white. Today's modern construction job calls for a trained psychologist with the patience of Job to exemplify all the old-time values while directing engineering and construction work which daily gets bigger, more difficult, and more complex. It takes 24 hours a day 7 days a week to do the job properly.

Need Many Talents

A good superintendent must have many long years of experience. He must have the ability to pick the right man for each key job, and the courage to delegate authority. He must have a hundred different manners for disseminating orders to various men. He must command their loyalty, and must keep close harmony among dissimilar individuals.

Today's superintendent must have the ability to select and plan the setup of plant outlays running into million-dollar figures and more. Unless he does it right the first time, his mistakes can break a contractor. Yet he must make his decisions without hesitation, and take all the responsibility if things go sour. He must get along with engineers and other people from the agency paying for the work. He must work in harmony with labour union bosses.

And last, though certainly not least, he must command just as much respect and confidence from the contractor-owners as he does from the lowest priced labourer on his job. It is an important factor in developing the financial backing a good superintendent must have on his job to show the best possible profit.

Nobody calls a superintendent in the middle of the night to say that things are going right. What they get him out of bed for is to shoot trouble and straighten things out.

In a way, such adverse factors as these are good for the construction business. A man either belongs in construction or he doesn't. He belongs, and he can go far, if he is man enough to accept such harsh rules and still look ahead to the deep inner satisfaction which comes from working with them and getting a job done right. Young men from the 1952 engineering schools who can forget 40 hours a week and concentrate on making these adverse rules a part of their lives 24 hours a day, 7 days a week, can practically write their own ticket a few years from now. For the rules are just as basic and even more essential to success than they were in Abraham Lincoln's time.

The man who gives this advice speaks, after considerable thought, from a 30-year background in Western construction and engineering. He is C. W. Wood, better known as "Smoky Wood", Vice President of General Construction Co. of Seattle and Project Manager of the USBR's big Hungry Horse Dam on the south fork of the Flathead River near Coram, Montana. Smoky Wood has supervised his share

of the big ones: first and second steps at Ross Dam, Hetch Hetchy Dam (O'Shaughnessy Dam, raised 85 ft. in 1935-36.—Ed.), Harbour Island Shipyard at Seattle, and Tacoma Shipyard. He was Assistant Superintendent on Bonneville Dam, the San Francisco-Oakland Bay Bridge piers, Owyhee Dam, and many smaller jobs. Wood has literally watched the construction business grow up.

Theories Useless Unless Practised

Like all theories or rules, the ones for a construction superintendent are no good unless they are used and lived with day after day for many years. How can a superintendent learn to command respect on a big job, for example, unless he has merited respect for many years on smaller ones? How can he straighten out trouble on a pressure grouting crew or help a rigger boss unless he has actually pressure grouted or worked at rigging himself?

To those who would be construction superintendents, then, one of the first things to do is to start living with the rules, ironing out adverse conditions, and practising all the things a man will need later on. Somehow all the priceless assets a man must have to direct big work must be sown, sprouted, nurtured and strengthened through the earlier, formative years. There is absolutely no substitute nor any short cut.

Smoky Wood's methods are his own, and they are not at all unique. They are what every successful construction superintendent uses, basically, and the difference is only in degrees. Jack McEachern, under whom Wood worked for many years, used the same basic rules coupled with a demand for near perfection from his subordinates as well as from himself.

"It was a definite and favourable factor in the professional growth of everyone who worked close to Jack McEachern," Wood explains, "because his demands helped everyone of these men grow; helped them become resourceful."

The School of Hard Knocks

When Wood was asked to name the things important these days to a superintendent, the first thing he put down was "EXPERIENCE," in big letters. Wood is a graduate engineer from the 1921 class at Colorado A and M and he believes an engineering education advisable or even necessary for men who want to be the construction superintendents of tomorrow. But in any discussion of the subject, he emphasizes the importance of practical experience in large quantities as soon as the formal schooling of the individual is finished.

"One of the valuable things about an engineering education is the fact that it gives a man an analytical mind," is the way Wood puts it. "A man with that kind of mind can analyse different aspects of a job, correct trouble, lower his costs, and do a better job than average of balancing the various economic values against each other. But they are not worth a damn unless a man makes up his mind to get some experience. How can you think, without the material to think with?

"Take the setup for a modern aggregate plant on a big concrete dam, for example, lots of things have to be balanced against lots of other things. How far is the haul? How far upgrade can you lift the stuff economically so the cableway can drop most of it into the dam, instead of having to do a lot of hoisting? How deep can you go in your gravel pit? What equipment should you select? How tough are the specs?

"Unless a man deliberately goes out as often as possible and exposes himself to learning some of these things first hand, he can't very well plan or direct such a setup. And it'll be even more important 10 or 20 years from now than it is today."

Think Objectively

Wood holds regular project conferences to promote harmony and understanding these days, as do most superintendents on big projects. The young man aspiring to become a superintendent himself some day can gain a lot of experience from these conferences by listening and keeping his eyes open on the job. At the very least, such conferences teach a man to think of a project in its broadest perspective. When a foreman of embedded metals can see that his work interferes at certain times with a higher priced carpenter crew, he has come a long way in this experience-perspective business.

There are many ways for a construction man to gain experience, and one of the soundest is at once the toughest and most obvious. If a man will simply demonstrate a willingness to

learn thoroughly a wide variety of jobs, it will pay dividends twice. First, it will teach him as nothing else can the fundamentals of a wide variety of work. Second, it will mark him at once as a man with a promising future. And construction management will see it, too, for that particular human trait is on the wane in this day of over-specialization and short hours.

How the other Guy does it

In addition to the wide variety of experience possible on any job, to be had for the asking, one of the important extra-curricular activities any would-be superintendent owes himself is an occasional visit to another construction job near by. A man can always see two things on any project. He can see some new innovation he can use sometime to his own advantage, or he can see mistakes he can profit by; mistakes he'll never make on his job. Either one is good experience.

The technical engineering-construction magazines of the trade are excellent extra-curricular material for broadening a man's theoretical experience, too, says Wood, whose office always contains current copies of many engineering periodicals. A Foreman would do well to broaden his knowledge by this type of reading, because much of the information he learns can be put to good use when the great day comes to take over his first superintendency.

The importance of grabbing big chunks of practical construction experience as fast as possible cannot be over-emphasized, because later on, how well a man has gained experience will determine how well he handles one of his toughest jobs—human contacts.

Demonstrate Abilities

In many respects, a superintendent's human contacts can make or break him faster than anything else. No superintendent is any better than the organization behind him; and to a large extent the organization is directly dependent on the superintendent for its creation, its work, and its efficiency or lack of it.

Many of the key men at Hungry Horse demonstrated their talents along various lines back in the days when the project manager was a Project engineer, foreman, or superintendent on jobs considerably smaller than the present one. The man who hopes eventually to be superintendent in his own right will do well to watch for other men with potential talent along various lines. It cultivates a healthy respect for the talents of other people, and that's good for anyone on a construction job. It's more than good for the man who, some day, will manage his own job and have to depend on many of these people to supervise the details.

Keep in Touch

Loyalty, harmony, mutual respect, confidence; all owe their existence to the intangibles in human contact. There are no set rules for making such things spring up and grow. But it seems highly significant that on the jobs where these things are most in evidence, the superintendent or project manager works harder at staying close to his job than ever.

Smoky Wood is no exception to this rule. The hours Wood has to spend on administrative matters in his office are so much drudgery as far as he is concerned, and he manages to delegate much of that work to administrative subordinates. Wood considers his most effective hours those he spends out on the job, close to details, and close to his men. Only by being close to his men can he sense incipient trouble in the making.

Possibly one of the worst causes of trouble and jealousy between men on a construction job is too little to do. There's always more trouble and jealousy in winter, when men are loafing along on a slow bell, than there is in summer when they're working their guts out to meet near-impossible schedules. It takes a good psychologist to understand that those tough schedules give a man character, and that if other conditions are right he'll feel prouder of having made an impossible schedule than he possibly could of having spent a few easy winter months.

Semantic qualifications and an engineer's thorough appraisal of all the facts may be fine in their place, but they're dynamite for a construction organization if they prevent a superintendent from giving fast, positive decisions. Let an outfit run into unforeseen conditions, such as those on most jobs. If the superintendent looks the situation over and then makes his decision rapidly on what scheme to use getting rid

of the trouble, he always commands respect. If he dillydallies around for days and weeks, it marks him as a man who lacks experience, and it almost always undermines the efficiency of his organization by losing him the respect he had from his men.

Be Cynical?

It may be all right for ministers to believe that all men are good *per se*, but a construction superintendent will build better human relations and a stronger organization with a much more negative—even cynical—attitude. Men simply are not all nice and civilized. They have jealousies just as apparent to a perceptive superintendent as those of a snarling dog whose supper is threatened by some intruder. Men have hates and angers and fears and insecurities, along with the nobler virtues. The smart manager of men will watch out for unhealthy attitudes and correct them, if possible. Many a good construction man got that way because some fine superintendent headed off his unhealthy attitudes and corrected his mistakes before they could happen.

It may be, if you look at this thing thoroughly, that here is the "secret" of many of the nation's top project managers. Help a man to broaden himself without making it obvious, and sooner or latter that man will see it for himself. When he does, he comes to love and respect "The Old Man," and to regard him as something of a wizard. He'll obey The Old Man's orders without question in the middle of the night. Here may be one explanation for the respect some men command on their jobs.

It might again be well to note that it took plenty of man-hours of work and interest, and an amazing series of right decisions and advice, to sow the seeds of that respect. Neither should it be forgotten that a good superintendent admits the mistakes he makes, and is quick to assume his full share of responsibility for whatever happens in his organization.

It is the sum and substance of all these things—a man's experience, the organization he builds, the professional excellence he displays, the human contacts he handles, the respect he commands—which go to make up his reputation. They determine whether his job shows a good profit, or a loss. And the superintendent who runs a profitable, harmonious job is the one who invariably gets infinite financial backing and good equipment from his contractor-owners, with a minimum of managerial interference. There are always a dozen ways to do a thing. If a superintentendent has built a good reputation, most people will let him do a job his way.

It should be emphasized again that there are no short cuts. Success follows only the somewhat revolutionary concept (for this day and age) that hard work is honorable, is a lot of fun, and gives great satisfaction. Unless a man is willing to devote all his time to his job, he'll never be a successful superintendent.

There are Rewards

Assuming that there are those who still are willing to pay this price and live by all the old-time values of life, the life of a top-notch construction superintendent has its rewards, spiritually as well as financially.

For who can doubt that when the President of the United States stood at rostrums dedicating such massive dams as Bull Shoals in Arkansas or Hungry Horse in Montain, the construction staffs who transformed these projects from paper to concrete commanded considerable respect in the President's mind?

Yes, building a big construction project has its problems, but it also gives its builder something to treasure for a lifetime.

—*With acknowledgments to "Western Construction", February, 1953.*

NEWS ROUND-UP

The Japanese Method of Paddy Cultivation.

In the Japanese method of growing paddy you must :--

(A) Grow stronger seedlings for transplanting ;

(B) Grow a better main crop ;

If both are done right your yields can be doubled or tripled !

Growing Seedlings by the Japanese Method.

1. *Plan for fewer seedlings per acre* :—Most farmers in India sow too many seed. Many good farmers plant only 20 pounds of seed for each acre to be put in paddy. Ask your local agricultural officer how much seed to sow on your land.

2. *Make a raised seedbed* :—You should plow paddy land right after the harvest. If plowing is not done after harvest, the land should be dug up and clods broken.

Your nursery seedbed should be four feet wide and three inches above the level of the ground and of any handy length. A space one foot wide should be left between the beds. This allows you to work and weed the seedbed without injuring the plants.

For each acre you plant in paddy, 1/20th of an acre must be sown for seedlings.

You sow 20 pounds of paddy seed for each acre planted to the crop. This many pounds of seed should be sown in a seedbed of 1/20th of an acre. Sow one pound of seed for about every 25 feet of bed.

Stir into the soil three baskets (about one maund) of compost or cowdung manure for each twentyfive feet of bed.

For each 25 feet of bed sprinkle two double handful (one pound) manure mixture. This mixture is made of equal parts of superphosphate and ammonium sulphate.

Smooth the soil, and then cover it with fine compost manure about 1/8th inch thick. Then cover the bed with a thin layer of ashes.

The bed is ready for the seed.

3. *Selecting good seed* :—Get the best seed. Ask your agricultural officer what seed you should use. Put these seeds into a bucket of salt water. The poor seed will come to the top. Skim these off and save only the heavy seeds in the bottom of the bucket for planting.

After the seeds have been selected, place them into Perenox mixed with water. Leave them in this mixture for 20 minutes.

4. *Planting the seed in the nursery* :—Two or three days before the rains, plant the seed. Cover the seed with 1/8th inch of fine earth.

If rains do not come on time, water the bed by water cans. Where there is canal and tank irrigation, this is not done and planting may be earlier.

5. *Caring for the seedlings* :— Seven or eight days after your seedlings come up, go through the beds and carefully remove all weeds. Your seedlings will be ready to transplant when the sixth leaf has formed. The plant will be 6 to 8 inches high at this time. It is better to transplant early than late.

Growing the Paddy Crop by the Japanese Method.

1. *Preparing the field* :—You should plow your paddy fields right after the harvest. Following the first monsoon rains the field should be plowed again. Your yields will be higher if a green manure crop is grown for turning under before transplanting.

Be sure to fill all cracks in the bunds. Pack these well to stop rats and crabs.

Manure must be used to get larger yields. Fifteen to twenty cartloads of compost or cowdung manure is needed for each acre. This manure should be plowed into the land before puddling. One hundred pounds of ammonium sulphate mixed with 100 pounds of superphosphate (or bone meal) may be used on each acre, but local officers should be asked about this.

Right way Wrong way

2. *Transplanting seedlings* :—Pull seedlings out one at a time and be careful not to bruise the stems or break the roots. If the soil is hard use a tool to loosen it. You should not jerk or hammer plants to remove soil.

When pulling up the seedlings, weeds must be removed.

Farmers using the Japanese method never plant more than four seedlings to the hole.

By this method, the seedlings are planted straight up rather than at an angle. You hold your fingers along the side of the plants and push them into the soil ahead of the seedlings. This way your fingers make way for the tender roots. The more roots you save the stronger your plants will be.

Your plants should be set in 10 inch squares. This is done by planting them in straight lines 10 inches apart in the line. There is 10 inches between each line (see picture in the opposite page).

To speed up planting, have two workers hold a long string in a straight line and on this string put markers 10 inches apart. The seedlings are placed in the soil at the markers. Then the string is moved over 10 inches and the planting at the markers is done again.

3. *Caring for the crop* :—After the crop has grown for two weeks the farmer must go through and remove all weeds. To get the highest yield you may use 100 pounds of ammonium sulphate mixed with 100 pounds of superphosphate one month after transplanting. (get local advice) You should work this manure into the soil around the roots of the plant (see picture). Working around the root increases yields.

From time to time you should move a soil scratching tool between the plants. About two weeks before flowering, field work should stop. Any more cultivation will lower yield.

From a pamphlet published by the Indian Council of Agricultural Research, Ministry of Food and Agriculture, New Delhi.